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FIRST WORLD-WIDE STUDY OF THE WOOD AND WOOD PROCESSING INDUSTRIES

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Main results of the study work on industrial sectors are presented in the Sectoral Studies Series. In addition a series of Sectoral Working Papers is issued.

This document presents major results of work under the element Studies on Wood and Wood Processing Industries in UNIDO's programme of Industrial Studies 1982/83.

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Preface

This study has been prepared by UNIDO's Division for Industrial Studies, Sectoral Studies Branch, with the aim of making an analytical appraisal of the status of the wood and wood processing industry in the world and to focus on the conditions that developing countries have to face in order to establish a successful domestic industry.

The study will be a background document to the first Consultation on Wood and Wood-processing industries to be held in Helsinki in September 1983. In order to give the necessary background to the discussions at the consultation the study takes a global approach and describes, at least in general terms, the delimitations of and interactions within the whole wood or forestry sector system.

Several UN agencies have collaborated with UNIDO in this study. Chapters 1 and 2 are based on "Wood Resources and Their Use as Raw Materials", prepared by FAO and issued as UNIDO/IS.399. The sections dealing with barriers to trade and occupational health and safety have been drawn up on the basis of special contributions by UNCTAD and ILO, which are issued separately. UNIDO is grateful for these valuable contributions and for the successful example of practical interagency co-operation that has been set. UNIDO would also like to thank IIASA and in particular the staff of the Forestry Project for their help and co-operation in the course of the work.

The study document draws on a large number of input documents and other reference material. Several of these documents will be issued as "Sectoral Working Papers". A list of these papers is found in the References, under item A.

This study will be revised and modified following the outcome of the Consultation Meeting and on-going work. We intend to improve and expand i.a. the scenario analysis and the analysis of trade and production development in different regions of the world.

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EXPLANATORY NOTES

References to dollars ($) are to United States dollars, unless otherwise stated.

A billion is 1,000 million

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

A slash between dates (e.g., 1980/81) indicates a crop year, financial year or academic year.

Use of a hyphen between dates (e.g., 1960-1965) indicates the full period involved, including the beginning and end years.

Metric tons have been used throughout.

The following forms have been used in tables:

Three dots (...) indicate that data is not available or is not separately reported.

A dash (-) indicates that the amount is nil or negligible;

A blank indicates that the item is not applicable.

Totals may not add up precisely because of rounding.

Besides the common abbreviations, symbols and terms and those accepted by the International System of Units (SI), the following abbreviations and contractions have been used in this report:

Economic and technical abbreviations

GDP	Gross domestic product
GFCF	Gross fixed capital formation

ISIC	International Standard Industrial Classification of all Economic Activities
LDC	Least developed country
MVA	Manufacturing value added
R and D	Research and Development
SITC	Standard International Trade Classification, Rev.1
t/a	Tons per annum
TCDC	Technical co-operation between developing countries
TNC	Transnational corporation

Organizational abbreviations

ASEAN	Association of South East Asian Nations
ATIBT	The International Technical Tropical Timber Association
ETTS	European Timber Trends Study
UN	United Nations
UNIDO	United Nations Industrial Development Organization
FAO	Food and Agriculture Organization
UNCTAD	United Nations Conference on Trade and Development
ILO	International Labour Office
IUFRO	International Union of Forestry Research Organization
ECE	Economic Commission for Europe
IIASA	International Institute for Applied Systems Analysis
GATT	General Agreement on Tariffs and Trade
SEALPA	Southeast Asian Lumber and Plywood Association
UNEP	United Nations Environmental Programme

Glossary

Forestry terms: based on "World Forest Inventory 1963" and "Tropical forest resources", FAO Forestry Paper No. 30, 1983.

Allowable annual cut:	volume that according to management plans can be removed from standing timber without depleting forest capital.
Annual increment:	the volume growth per year of standing timber; sometimes expressed as "gross annual increment" without deducting natural losses, or as "net annual increment", net of natural losses.
Broadleaved:	or non-coniferous refers to trees classified botanically as "angiospermae" in the trade also sometimes referred to as "hardwoods".
Closed forest:	forest with closed canopy, in contrast with forest with open canopy which are referred to as "other wooded lands".
Coniferous:	refers to trees classified botanically as "gymnospermae", in the trade also sometimes referred to as "softwoods".
Forest:	vegetative association made up by trees.
Forest under management:	forest with classical management plans, or any type of forest where extraction of roundwood is subject to some institutional regulation.
Growing stock:	total volume of standing timber expressed as gross bole volume of trees above 10 cm diameter at breast height.
Operable forest or productive forest:	closed forest which is considered productive; excludes forest which is classified as unproductive by legal restrictions, or because of poor quality. Some countries include economically inaccesible forest as unproductive.

Forest product terms: based on "Classification and Definitions of Forest Products", FAO Forestry Paper No. 32, 1983.

Fuelwood:	wood in the rough used as a source of energy.
Industrial roundwood:	all wood in the rough not used for fuelwood.
Other industrial roundwood:	wood in the rough used as poles, piling and posts and other uses in the rough.
Pulpwood:	wood in the rough used as a raw material input in the pulp and paper industries, and in some cases, in fibreboard and particle board.

Roundwood:	all wood in the rough as harvested in the forest.
Sawlogs and veneer logs:	roundwood destined for the veneer, plywood and sawnwood industries.

Secondary processing terms:

Furniture:	refers to household, office and institutional furniture and built-in cabinets and counters made primarily of wood.
Gluelam:	Glued laminated beams straight or curved made up of selected sawn and planed pieces of wood glued on their flat, normally jointed endwise to produce longer lengths of acceptable strength.
Joinery:	includes doors and doorsets (i.e. with frames), windows and frames, mouldings and trim, stairs, flooring (tongue and groove, parquets, etc.), non-load-bearing wooden partitions and shop fittings.
Portal frames:	main structural framing members comprising columns and rafters usually ridged, jointed with mailed plywood or sawnwood gussets or metal connector plates.
Quality assurance:	involves certification (through labelling, usually) of product quality by an independent body or "third party".
Quality control:	procedures followed in a mill or factory to ensure that products meet specified standards.
Temporary works:	engineered structures used in construction to support concrete and such vehicles, men and equipment as required; includes formwork, falsework, scaffolding and earthworks.
Trussed rafter:	a roof support, usually triangular in outline and having all timber components of the same thickness (monocline) and joints made from metal connector plates, bolts or nailed plywood.

Country groupings

The grouping of countries used in this paper, if not otherwise indicated, is as given below. This list of countries is not comprehensive; it includes only those countries with a recognized forestry potential.

The developed regions: all developed countries are grouped as follows:

- North America: Canada and the USA
- Europe: excluding the USSR.
- the USSR.
- "other" developed countries: all "other" countries with direct importance for forestry: Japan, Australia, New Zealand, South Africa .

The developing countries are grouped by continents, and in sub-regions as shown below. Sub-regions considered as "temperate" are marked with an asterisk.

Latin America

Central America: Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama

Caribbean and CARICOM: Cuba, Dominican Republic, French Guyana, Haiti, Suriname, Belize, Guyana, Jamaica, Trinidad and Tobago

South America-tropical: Bolivia, Brazil, Colombia, Ecuador, Paraguay, Peru, Venezuela

South America-temperate*: Argentina, Chile, Uruguay

Africa

Mediterranean: Algeria, Egypt, Libya, A.J., Morocco, Tunisia

Northern Savanna: Chad, Mali, Mauritania, Niger, Senegal, Upper Volta

West Africa: Benin, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Nigeria, Sierra Leone, Togo

Central Africa: Angola, Cameroon, Central African Republic, Congo, Equatorial Guinea, Gabon, Zaire

East Africa: Burundi, Ethiopia, Kenya, Rwanda, Somalia, Sudan, Tanzania, Uganda

Southern Africa: Botswana, Madagascar, Malawi, Mozambique, Namibia Swaziland, Zambia, Zimbabwe

Asia

Asia Near East*: Afghanistan, Iran, Iraq, Jordan, Lebanon, Syria, Turkey

East Asia*: China, Mongolia, Democratic People's Republic of Korea, Republic of Korea

South Asia: Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka

Continental South-East Asia: Burma, Kampuchea, Laos, Thailand, Vietnam

Insular South-East Asia: Brunei, Indonesia, Malaysia, Philippines Fiji, Papua New Guinea, Solomon Islands

The breakdown of developing countries is done on the following basis:

Developing temperate: South America-temperate, Asia Near East, East Asia

Developing tropical: all other developing sub-regions not marked with an asterisk

Introduction and structure of the report

This draft of the first World-Wide Study of the Wood and Wood Processing Industries is issued as a background document to the first Consultation on Wood and Wood Processing Industries, to be held in Helsinki, in September 1983. Its scope and aim, however, are considerably broader than giving background information at the Consultation. It is hoped that the study will be of practical use for decision makers in developing countries as well as for the technical assistance activities of UNIDO and other organizations. It is also hoped that it will serve an information purpose within the UN system as well as for UNIDO's member countries.

The study has the same general approach as the world-wide studies of other sectors. It is a macro-oriented study which looks at the sector as a whole rather than a micro-analysis at the enterprise or project level. It tries to perform the analysis in terms of accepted statistical conventions in order to facilitate comparisons and to achieve consistency, both internally and with other studies. The study is not a technical document and even in sections treating technological issues it does not attempt to give detailed practical advice on how to select appropriate technologies, etc. Instead the study focusses on the contribution to the industrialization and development process which can be given by the wood and wood processing sectors. It is necessary to perform such an analysis in the form of a comparison of alternatives. The final choice between alternatives must, however, always be done with specific prevailing conditions in mind and by the developing countries themselves in order to assure full compatibility with their development and social objectives. The study aims only to point towards likely consequences of alternative choices.

Following the overall research strategy of UNIDO, this first analytical appraisal will be followed by more specialized studies focussing on elements of alternative strategies and on international actions for co-operation. The current study contains a set of conclusions.

The study begins with an overview of the wood and wood processing sector. After a discussion of the various components of the forestry based system and its interaction with other parts of the socio-economic system a review (based on FAO's work), of the study of the forest resources of the world and their use is carried out. The overwhelming impression of the review is that of an imbalance between the distribution of forest resources and the processing of these resources between industrialized and developing countries. The role of logging and transportation systems, is analysed in Chapter 2. The third chapter reviews the main characteristics of the mechanical wood processing industries (including energy, manpower and research requirements as well as environmental constraints) and identifies the main obstacles of the developing countries in establishing such industries. Another type of obstacle for developing countries is analysed in Chapter 4, namely that connected with international trade and price behaviour. The unbalanced trade flows - to the detriment of the developing countries - are described and an analysis of various barriers to trade operating against the export of more processed goods from developing countries is undertaken. In chapter 5 some policy-related issues are discussed and the role of the sector in the industrialization process is described. Necessary incentives and other prerequisites in order to ensure a shift from exports of logs towards domestic processing in developing countries are outlined and a discussion of possibilities for relocation of industries to developing countries is carried out, based on a special study concerning South-East Asia. Chapter 6 again deals with marketing and promotion aspects, for example, the need for promotion of the use of tropical timbers, in particular the commercially less accepted species. The need for other marketing activities is also stressed. Chapter 7 draws the necessary conclusions: the potential exists for a strongly increased degree of domestic processing and for the relocation of industries to developing countries. They could supply both domestic, regional, and overseas markets although, there are several constraints that need to be overcome. Notably, however, the scale constraint is less pronounced in this industry than in many others.

The macro-oriented approach of the study will by necessity mean that many technological specifics will be missing. However, the approach offers assistance to development planners and to decision-makers within the sector in an economy-wide perspective.

The focus of the study is on the necessary prerequisites for stimulating a development of the wood processing industries in the developing countries as well as for a promotion of the use of wood and wood products everywhere. These were also selected as issues for the Consultation by the Global Preparatory Meeting in January 1983.

CHAPTER 1 The wood and wood processing sector in the world

1.1 The forest sector system

1.1.1 Main components of the system

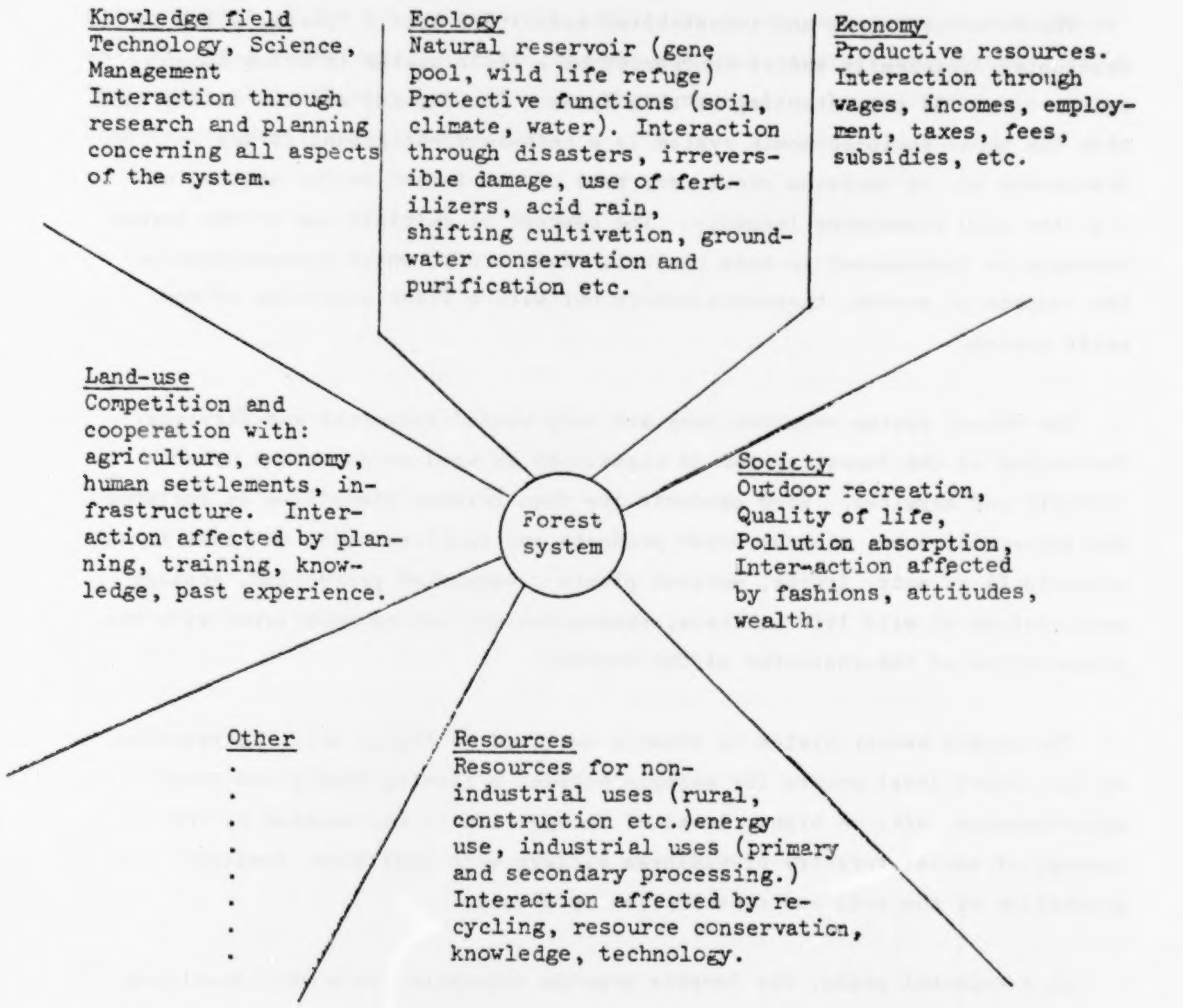
The forest resource and forest-based activities form a system, which is developing dynamically and is confronted by a wider system in which human beings live. An understanding of this dynamic development and the interaction with the whole socio-economic system is a necessary background to any discussion of, or decision about, any part of the forest sector system, as e.g. the wood processing industry. The concept of multiple use of the forest resource is fundamental in this context. This study, which concentrates on the industrial sector, therefore starts out with a wider over-view of the whole system.

The forest system supplies many and very varied resources and services. The output of the forest system is classified as wood products and other products and services. Wood products are then further classified as fuelwood and industrial wood, whereas other products and services refer to minor forest products (e.g. nuts, fruits, medical plants), watershed protection, ecology preservation of wild life habitats, recreation and values associated with the preservation of the character of the forest.

The forest sector system is broadly outlined in Figure 1.1. Interaction at the lowest level occurs for example between a farming family and their agro-forestry unit. A higher level of interaction is represented by the concept of social forestry providing a village with fuel wood, shelter, protection of the soil and construction materials.

On a regional scale, the forests provide resources for a well developed economy and at the same time protect watersheds, keep ground water, provide outdoor recreation and in general, improve the quality of life. On a national level, the supply of domestic forest resources affect national self-reliance, the trade balance, employment, revenues, etc.

Figure 1.1. Multiple use of the forest resource and interaction between the forest system and other parts of the socio-economic system



Knowledge field
Technology, Science, Management
Interaction through research and planning concerning all aspects of the system.

Ecology
Natural reservoir (gene pool, wild life refuge)
Protective functions (soil, climate, water). Interaction through disasters, irreversible damage, use of fertilizers, acid rain, shifting cultivation, groundwater conservation and purification etc.

Economy
Productive resources.
Interaction through wages, incomes, employment, taxes, fees, subsidies, etc.

Land-use
Competition and cooperation with: agriculture, economy, human settlements, infrastructure. Interaction affected by planning, training, knowledge, past experience.

Forest system

Society
Outdoor recreation,
Quality of life,
Pollution absorption,
Inter-action affected by fashions, attitudes, wealth.

Other
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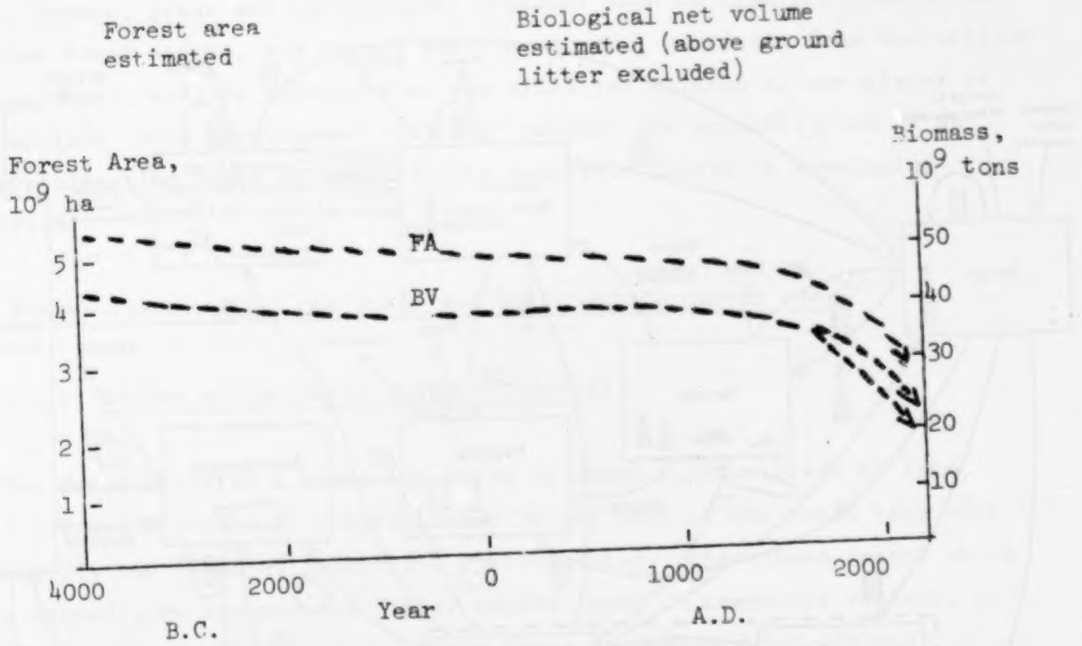
Resources
Resources for non-industrial uses (rural, construction etc.)energy use, industrial uses (primary and secondary processing.)
Interaction affected by recycling, resource conservation, knowledge, technology.

The forests purify the air, being three times as effective in this as agricultural areas. Forests are also seen as important components of the quality of life; of a total of 31 indicators about the quality of life listed in UNESCO[1/] 1978), 15 are positively affected by forests.

Figure 1.2 shows an estimate of the secular changes in the forest areas of the world. The industrial use of wood has had only a marginal effect on the depletion of the resource, as compared to the impact of clearing for agriculture, fuelwood, urbanization, etc. The problem of deforestation is discussed in section 1.2.4 below. Over the long-run world forest resources are declining.

Figure 1.2 Probable change in the area and biomass of the earth's forests from the year 4000 B.C. to 2050 A.D.

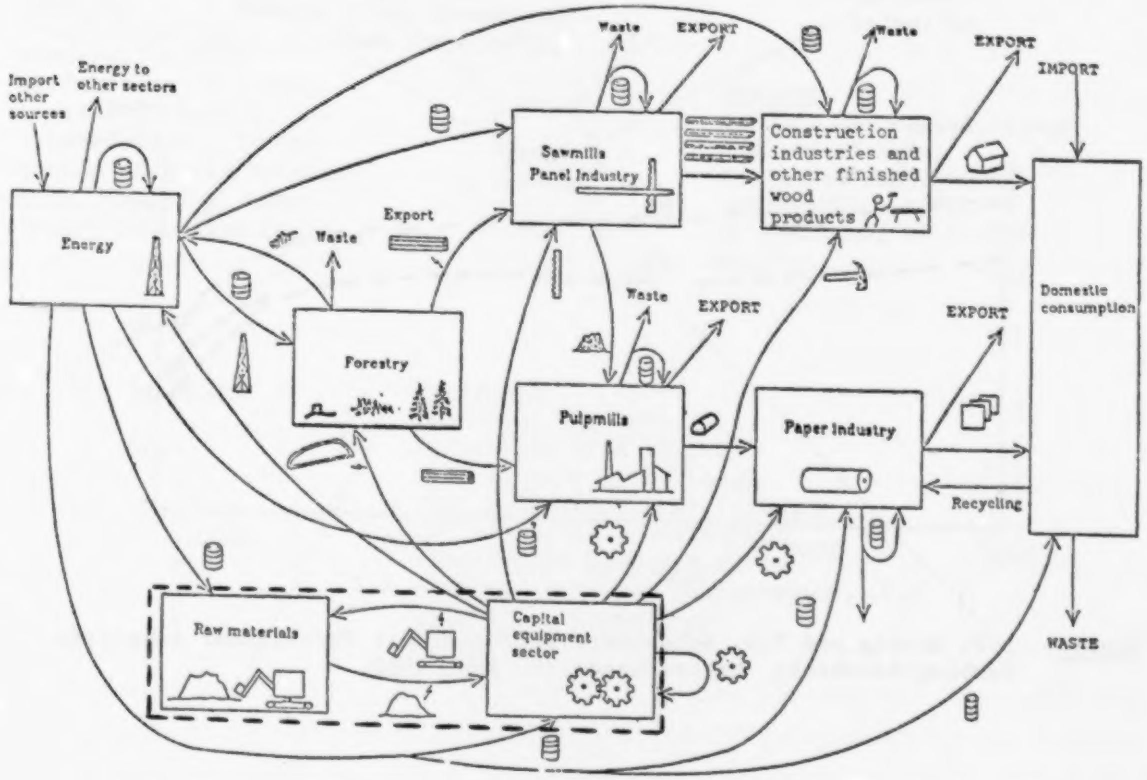


Source: E.F. Brunig and T.W. Schneider, Verfügbarkeit Forstlicher Rohstoffe, Hamburg-Reinbeck: Mitteilungen der BFH, 1980.

[1/] UNESCO, Indicators of Environmental Quality and the Quality of Life, 1978.

Figure 1.3 depicts the economic part of the forest sector system and a typical forest-industrial inter-relationship. This part of the system is characterized by three types of flows: flows of fibres, energy and capital equipment. In the future, other components and new linkages will enter the field. For instance, vertical integration in the paper sector could lead to inclusion of publishing, which in turn connects with in the electronic media field. Moreover, as societal and ecological services are becoming more important, the corresponding areas of the forest sector may eventually offer marketable goods in these fields. New resources may also be extracted from forests such as natural insecticides, medicines and other chemicals.

Figure 1.3 The economic part of the forest sector system


Import other sources
Energy to other sectors
Energy
Waste
EXPORT
Sawmills Panel Industry
Waste
Construction industries and other finished wood products
EXPORT
IMPORT
Export
Waste
Forestry
Waste
EXPORT
Pulpmills
Paper industry
EXPORT
Domestic consumption
Recycling
Raw materials
Capital equipment sector
WASTE

1.1.2 The physical flow of fibres

The physical flow of fibres is outlined in Figure 1.4. Increased use of residues and wastes can increase the availability of fibres but will also affect the sustainability of the resource. Recycling is another concept to increase availability of the resource. Most wood products can be recycled, and their energy content can in the end be recovered by burning or through destructive distillation.

The industrialization of the developing countries and the increased domestic processing of wood can be seen as an upgrading of fibres available there. Furthermore, with the help of a general technological development, it becomes possible to use more and more wood species and more and more low quality types of fibres for even more products. Thus, materials such as reeds, bamboo, grass and agricultural residues such as bagasse, flax shives, jute and kenaf sticks, and cereal and rice straws, partially from new origins (e.g. swamps), will be processed at new sites and shipped to new places of consumption. This development will also enhance the possibilities of an industrialization based on domestically available fibres in developing countries.

1.2 Forest resources of the world and their main economic uses[2/]

1.2.1 Review of the world forest resources

The total forested area of the world is about 4,100 million ha (see Table 1.1 and Figure 1.5) covering some 30 per cent of the world land area. Customarily two types of forest are distinguished: the closed forest which has a closed tree canopy, and "other wooded land" in temperate regions, or open forest in tropical regions, where trees predominate but without constituting a full tree canopy. It is estimated that in the developing regions 1,015 million ha of forests are in the temperate zone, and 1,200 million ha are in the tropical forests. The total volume of growing stock in

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[2/] Except where otherwise indicated, this section is based on the contribution by FAO to the world-wide study. The FAO document is issued as Wood Resources and Their Use as Raw Material, UNIDO/IS.399.

Figure 1.4 A diagramatic outline of the physical flow of fibres, not to scale

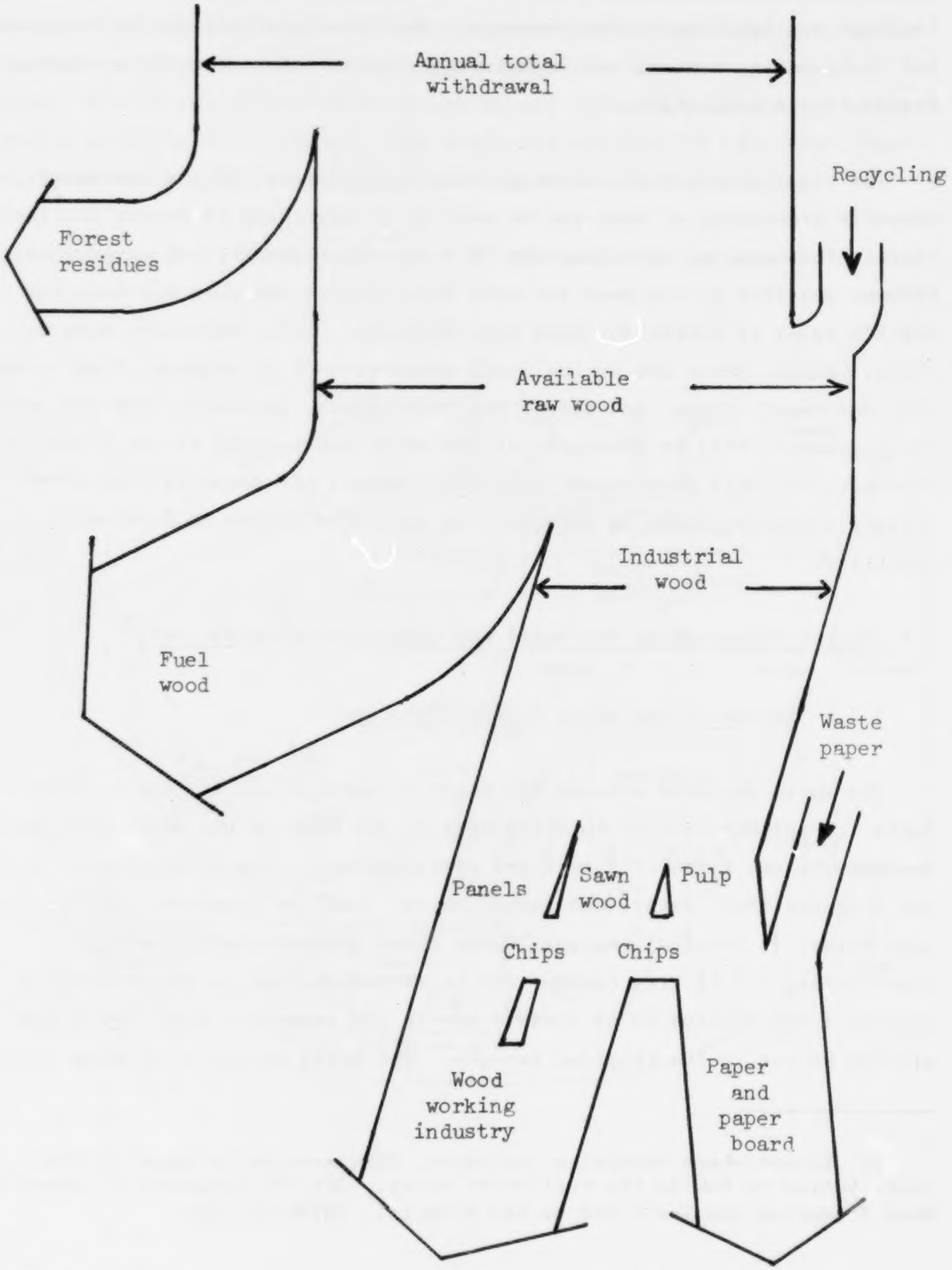

Annual total withdrawal
Recycling
Forest residues
Available raw wood
Industrial wood
Fuel wood
Waste paper
Panels
Sawn wood
Pulp
Chips
Chips
Wood working industry
Paper and paper board

Table 1.1. The world's forest resources

Regions	Population million	All forest Area million ha	Operable Forest Area million ha	Operable Forest Volume of growing stock, billion m^3
Developed	1,164	1,910	940	96
Developing:				
Temperate	1,189	1,015	150	12
Tropical	2,062	1,200	885	162
Total developing	3,251	2,215	1,035	174
Total world	4,415	4,125	1,975	270

Source: FAO, Wood resources and their use as raw material, op. cit. p.3.

the operable forests is estimated at some 270,000 million m^3, of which 108,000 million m^3 are in the temperate regions and about 162,000 million m^3 are found in the tropical forest.

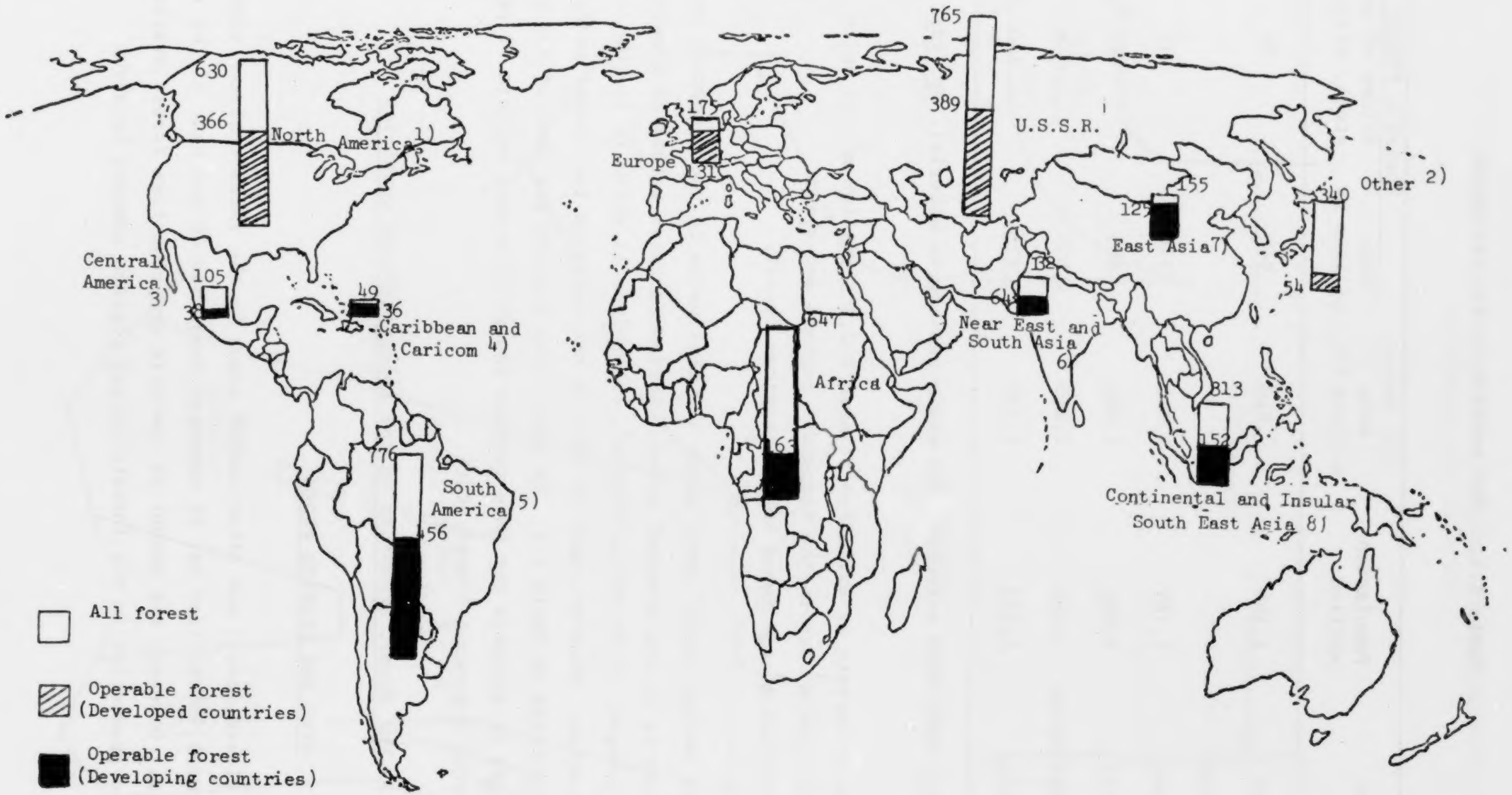
"Other wooded lands" cover about 400 million ha in the temperate zone and 750 million ha in the tropical areas. Estimated total volume of growing stock in this category is 20,000 million m^3, two-thirds of which is in the tropical areas. However, most of this is not suitable for forest industrial use as indicated in Table 1.1. In fact, less than 50 per cent of the total forest area is suitable for this purpose though this does contain 77 per cent of the world's growing timber stock.

1.2.2 The forest resources in the industrialized countries

Area and growing stock

The closed forest and other wooded areas in the industrialized countries cover some 1,900 million ha, or somewhat less than 40 per cent of the total land area. However, the amount of operable or productive forest available for roundwood production in the industrialized regions amounts to about

Figure 1.5. The World's Forest Resources (in million ha) (see country listing next page)


630
366
North America 1)
Central America 3)
105
38
49
36
Caribbean and Caricom 4)
776
456
South America 5)
17
131
Europe
647
163
Africa
765
389
U.S.S.R.
132
64
Near East and South Asia 6)
155
125
East Asia 7)
813
152
Continental and Insular South East Asia 8)
340
54
Other 2)
All forest
Operable forest (Developed countries)
Operable forest (Developing countries)

Note: This list is not comprehensive, it includes only those countries with a recognized forestry potential.

1/	North America	Canada and the USA
2/	Other	Australia, Japan, New Zealand and South Africa.
3/	Central America	Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama
4/	Carribean and CARICOM	Cuba, Dominican Republic, French Guyana, Haiti, Suriname, Belize, Guyana, Jamaica, Trinidad and Tobago
5/	South America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela
6/	Near East and South Asia	Afghanistan, Bangladesh, Bhutan, India, Iran, Iraq, Jordan, Lebanon, Nepal, Pakistan, Sri Lanka, Syria and Turkey
7/	East Asia	China, Democratic Republic of Korea, Mongolia and Republic of Korea
8/	Continental and Insular South-East Asia	Brunei, Burma, Fiji, Indonesia, Kampuchea, Laos, Malaysia Philippines, Papua New Guinea, Solomon Islands, Thailand and Vietnam.

940 million ha after deducting the "other wooded areas" with only limited tree coverage and forest that is not productive for a variety of reasons such as physical or economic inaccessibility or a variety of legal constraints designed to preserve the forest. (See Table 1.2).

The total growing stock, given as the bole volume of all trees, is estimated at about 140,000 million m^3 for all the closed forest, while the figure for the closed operable forest is about 96,000 million m^3, of which North America, Europe, and the USSR together account for some 90,000 million m^3. These volumes represent the productive forest capital of the developed world.

Moreoever, the coniferous species represent more than three quarters of the total growing stock in the operable forests. Geographically the coniferous species are predominant in the colder climate of the north, and in the higher altitudes in the south. Moving south, the broad-leaved species appear and gradually replace the coniferous species as the dominant forest types. As population densities are low in the north, these relatively undisturbed large coniferous forests offer a substantial potential to the forest industries. The situation in the main regions is summarized below.[3]

Table 1.2. The productive forest resources of the industrialized world

Regions[a]	Area in million ha	Volume in 1,000 million m3	
		Total	Coniferous
North America	366	36.4	26.6
Europe	131	14.1	8.8
USSR	389	40.0	33.2
Other	54	5.5	3.9
Total industrialized regions	940	96.0	72.5

Source: FAO, Wood resources and their use as raw material, op. cit., p.6.

[a] For a list of the countries included in each region, see Glossary.

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[3] For a detailed review see FAO: Wood Resources and Their Use as Raw Material), op. cit.

North America

Canada and the USA have about the same total forest area, i.e. 325 million ha and 305 million ha, respectively, or about 35 per cent of the total land area. On the other hand, there is a significant difference in population size: Canada now has approximately 25 million inhabitants and the USA has 225 million. Moreoever, both countries also have roughly the same growing stock of standing timber at around 22,000 million m^3, though in Canada this is 80 per cent coniferous forest, while in the USA it is only 65 per cent.

The growing stock per ha in Canada is about 70 m^3/ha while in the USA this figure reaches over 100 m^3 /ha. Furthermore, net annual increments in Canada are considerably lower, reflecting its more northernly location. With regard to ownership, sharp differences occur between the two countries. Public ownership in Canada accounts areawise for 92 per cent of all closed forest, while in the USA 27 per cent of the productive forest is in public owernership and 73 per cent in private ownership.

Europe (except USSR)

Europe has an area of forest and other wooded land of 175 million ha, representing slightly more than 30 per cent of its total land area. This percentage is much higher in the Nordic countries (52 per cent) and lowest in the ten EEC countries (22 per cent), in inverse ratio to the population densities. Of this total forest area, 131 million ha of forest are considered operable for industrial production.

The total growing stock of the operable forest is estimated at about 14,100 million m^3, of which 63 per cent is coniferous. This represents an average growing stock per ha of about 108 m^3 for Europe, but with wide extremes on a country-by-country basis; 85 m^3/ha in the Nordic countries, 100 m^3/ha in the EEC, 250 m^3/ha in Central Europe, and 150 m^3/ha in Eastern Europe.

On average 53 per cent of the forests in Europe is in public ownership, with the lowest proportion in the Nordic countries (less than 25 per cent), about 75 per cent in Southern Europe and the highest in Eastern Europe, above 92 per cent. Management plans cover between 85 and 100 per cent of all publicly owned forest, except in Southern Europe. For privately owned forest, management plans exist for little over half the area in the Nordic countries and Western Europe. However, the other operable forest is practically all covered by some cutting regulations.

USSR

The USSR resources[4/] correspond to 21 per cent of the world's forests and account for more than a quarter of the growing stock. The net annual increment is comparatively low, reflecting unfavourable climatic conditions and large areas of mature forest. Forests are spread over vast northernly sub-temperate areas, while population is mainly concentrated in the west and south-west of the country.

In 1978, some 792 million ha or 45 per cent of the total land area was classified as forest area. Of this, slightly more than half was considered operable, being physically accessible and with logging plans.

The total growing stock of all forests is estimated at 84,100 million m^3, while the growing stock of the operable forest is around 40,000 million m^3. Coniferous species represent about 83 per cent of the operable forest stock.

Other areas

Remaining areas in the developed world are diverse and not very significant in terms of productive forest. They include Japan, Oceania, New Zealand and South Africa.

[4/] See The USSR Forest and Woodworking Industries, prepared by N.A. Burdin and V.A. Sylantyev, UNIDO/IS., 1983, forthcoming.

1.2.3 The forest resources in the developing countries

The forest and other wooded areas in the developing countries cover approximately 2,215 million ha, whereas the amount of operable forest is about 1,035 million ha or 47 per cent of the total forest area. In the tropical developing parts of the world, approximately 27 per cent of the closed forest is inoperable (See Tables 1.1 and 1.3). The following three sections summarize the situation in the three main developing regions, namely Latin America, Africa and Asia.

Table 1.3 Percentage of closed forest which is inoperable, by tropical region, 1975

	In closed hardwood forests	In closed softwood forests	In all closed forests
Africa[a/]	34 %	79 %	34 %
America[b/]	21	18	21
Asia and Oceania[c/]	35	27	35
All tropical	27	24	27

Source: FAO, Tropical Hardwood Resources in Tropical Hardwood Utilization (ed. Roelof A.A. Oldman), Martinus Nijhoff Publs., The Hague, 1982, Table I-2-1.

a/ Africa south of Sahara without Lesotho, South Africa and Swaziland.

b/ Latin America without Argentina, Chile and Uruguay.

c/ From Pakistan east without Australia, China, Japan, Democratic People's Republic of Korea, Republic of Korea, Mongolia, New Zealand.

Latin America

The forest resources in Latin America cover some 930 million ha of forested land, of which 690 million ha are considered to be closed forest. These forests serve a population of 370 million inhabitants in a total area of 20 million km^2, 17 million km^2 of which are in South America. Areas and growing stock in operable forests are given in Table 1.4.

Table 1.4 The productive forest resources of Latin America

Sub-regions[a]	Area in million ha		Volume of growing stock in million m^3
	Operable forest	Under management	
Central America	38	0.3	3,800
Caribbean & CARICOM	36	0.2	7,300
South America - tropical	447	...	67,600
South America - temperate	9	...	1,200
Total Latin America	530	0.5	79,800

Source: FAO, Wood Resources and Their Use as Raw Materials, *op. cit.*

[a] For a list of the countries included in each subregion, see Glossary.

Central America In the countries from Mexico to Panama, the closed forest covers an area of 64.9 million ha of which 38.5 million ha are considered to be productive, though with only about 300,000 ha under management in Nicaragua and Honduras. Mexico has more than 60 per cent of the productive forests of the region. Mexico's coniferous forests account for 93 per cent of all productive coniferous forest in Central America.

The total growing stock of all closed forest is estimated at 5,200 million m^3. Some 3,800 million m^3 of this is in the productive forest, which has 1,100 million m^3 of coniferous species.

Growing stock for broad-leaved species reach 110 m^3/ha while those for coniferous species average about 75 m^3/ha, but in some areas averages are reported to be near 200 m^3/ha.

The total area of plantations has reached 185,000 ha, of which about one half is coniferous. Similarly, about one half is intended for industrial use.

Caribbean and Caricom This subregion includes the Caribbean islands and the countries of the Northern Atlantic Coast of the South American continent. The total area of closed forest is estimated at 46 million ha, of which some 36 million ha are found in Guyana, Surinam and French Guyana, and some 0.4 million ha are of coniferous species, half of them in Cuba. The total area of mangrove adds up to 825,000 ha.

The total growing stock of all closed forest is estimated at some 8,000 million m^3, of which some 7,250 million m^3 are considered to be in productive forest. These data would indicate an average growing stock of nearly 200 m^3/ha, which seems a fair indicator of its potential, however, some areas of higher density are known.

Some 200,000 ha of plantations have been reported, more than three quarters are in Cuba. About one half is stocked with coniferous species but the current rate of planting is two thirds coniferous.

South America-North (tropical) This subregion covers South America north of the Tropic of Capricorn except for Guyana, Surinam and French Guyana. The area is characterised by the large forested Amazon basin with Savannah areas to the south and east, and in the west the mountain range of the Andes. The Amazon basin, by far the largest tropical broadleaved forest in the world, stretches out over some 550 million ha.

The total area of closed forest is estimated at some 570 million ha, which represents 80 per cent of the total Latin America forest resources. Of those forest areas, some 450 million ha are considered productive, and this represents some 40 per cent of the world's productive forest reserves, with 300 million ha in Brazil. This region also has some 3.5 million ha of mangrove forest.

The total growing stock of these closed forests is estimated at some 78,000 million m^3, of which 67,600 m^3 are in the productive forests. Of this operable timber, 47,000 million m^3 are in Brazil. This gives an average growing stock of some 150 m^3/ha, but in some areas volumes of between 200 and 250 m^3/ha are reported with even higher volumes for the Parana Pine.

By 1980, the total area of plantations had reached 4.2 million ha, of which 90 per cent is in Brazil.

The dominant type of ownership is public, although with variation due to historical and local factors.

South America-South (temperate) The area of productive forest is estimated at 9.1 million ha. Volume density estimates for the growing stock range from 50 to 70 m^3 per ha. Practically all the natural forest is broad-leaved except for pine stands in Chile and Brazil. A decreasing volume per ha is evident when going south. Virtually none of the natural forest is under management. The plantation program is substantial, the total area reaching 1.5 million ha, of which about 60 per cent is coniferous. More than 80 per cent is for industrial use, the remaining for fuelwood.

Africa

The operable forest in Africa is over 169 million ha (see Table 1.5). Between 1 to 2 per cent of this is in softwood forests.[5] Approximately one third of the total closed forests is inoperable.[6] These forests serve a population of 348 million inhabitants.

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[5] FAO, Tropical Hardwood Resources, op. cit.,Table I-2-1, p. 29.

[6] ibid.

West Africa This subregion, has tropical evergreen forest vegetation mainly along the coast. The total area of closed forest covers some 18 million ha, of which only 11.3 million ha are considered productive. One million ha are under management (see Table 1.5). Of the 6.7 million ha of unproductive forest, 5.6 million ha are inoperable for physical reasons which include poor quality as well as inaccessibility. Total growing stock in the closed forest is estimated at about 2,900 million m^3, of which roughly 2,000 million m^3 are operable forest. This gives a volume of about 177 m^3/ha. Intensive forest management does not seem to exist on a large-scale in this region. The total plantation area is estimated to have reached 330,000 ha, 70 per cent of it is in Nigeria. The coniferous component is negligible.

Table 1.5. The productive forest resources of Africa

Subregions[a]	Area in million ha Operable forest	Under management	Volume of growing stock in million m^3
Mediterranean	0.2	0.1	40
Northern Savannah	6.5	..	300
West Africa	11.3	1.0	2,000
Central Africa	137.6	0.2	35,300
East Africa	4.1	..	400
Southern Africa	9.5	0.7	1,000
Total Africa	169.2	2.0	39,000

Source: FAO, Wood Resources and Their Use as Raw Material, op. cit.

[a] For a list of the countries in each subregion, see Glossary.

Central Africa This subregion covers an area of 5.3 million km^2 and it includes the large humid tropical forest of Central Africa. The total area of closed forest covers some 173 million ha, of which 138 million ha are considered operable (see Table 1.5). The total growing stock in Central Africa is estimated to reach nearly 40,000 million m^3 of which somewhat more than 35,000 million m^3 are in the productive forest. The productive forest is thus very rich volume-wise, with an average of around 250 m^3/ha. The total plantation area is estimated at 235,000 ha, of which more than two thirds is in Angola.

The Mediterranean This subregion has very little forest except in the Maghreb countries; the forests being mainly broad-leaved with some coniferous species. The growing stock is estimated to have a volume of about 60 m^3/ha for the 100,000 ha of managed forest. The rest of the region has xerophytic to desert conditions. The annual plantation program is estimated at approximately 20,000 ha and is mainly oriented towards hardwood production.

Northern Savannah This subregion also has very little forest except on the southern fringe, where limited forest associations of the Sudano-Guineaese type appear that have some growing stock of sawlog size. The area of closed forest is estimated at some 44 million ha, of which about 6.5 million ha are considered productive with a growing stock of 300 million m^3. More important is the wider area of wood vegetation, all xerophytic associations estimated to cover some 130 million ha and producing fuelwood, roundwood and many other non-wood products. The total area of plantation is estimated at 37,000 ha, all in broad-leaved species.

East Africa The total closed forest area is about 9.7 million ha of which about 4.0 million ha are classified as productive (see Table 1.5). Some 1.1 million ha of the forests are coniferous, of which about 60 per cent are productive. Total growing stock of the closed forest is estimated to be over 900 million m^3, of which 400 million m^3 in productive forest. About half of the forest is undisturbed and forest management plans exist for only about 15 per cent of the area. The growing stock of productive coniferous forest is 66 million m^3. The total plantation area is estimated at 650,000 ha, mostly in the Sudan, Kenya, and Ethiopia.

Southern Africa The total area of closed forest is about 15 million ha, of which over 9.0 million ha are considered productive with 650 000 ha under management (see Table 1.5). Total growing stock in closed forest is estimated at 1,000 million m^3, of which 770 million m^3 in productive forest, but average volumes per ha are not very high. Nevertheless over 200 m^3/ha have been found in some areas.

Asia

The forest resources in Asia, continental Asia and the S.E. Asian archipelago cover some 600 million ha of forested land, of which some 425 million ha are considered to fall in the category of closed forest. These forests serve a population of 2.4 billion inhabitants over a total land area of 27 million km^2. The productive forest resources are shown in Table 1.6.

Table 1.6 The productive forest resources of Asia

Subregions[a]	Area in million ha Operable forest	 Under management	Volume of growing stock in million m^3
West Asia, Near East	15[b]	...	1,830[b]
East Asia	125	...	9,700
South Asia	49	33.1	3,840
Continental South-East Asia	41	3.5	6,650
Insular South-East Asia	111	2.5	21,000
Total Asia	341[b]	39.1[b]	43,020

Source: FAO, Wood Resources and Their Use as Raw Material, op. cit.

[a] For a list of countries in each subregion, see Glossary

[b] incomplete due to lack of data for certain small areas in West Asia.

West Asia and the Near East This subregion is characterised by a limited forest cover. At present, some forest resources remain in a few countries and provide some roundwood for local industries and consumption. Data on the region are incomplete.

East Asia This subregion includes China, which accounts for 122 of the 125 million ha of operable forest in the region. In terms of land area, forests and population, China has a predominant position. However, in view of the wood requirements of the population, it is accepted that the present forest estate, covering only 12 per cent of the total land area, is insufficient. China has already accomplished 30 million ha of reforestation two thirds of which are for timber production. Plans exist for reforestation of an additional 40 million ha by the year 2000.

South Asia The area of closed forest is estimated at some 60 million ha, of which 49 million ha are considered productive. The total growing stock is estimated to be nearly 4,400 million m^3, of which about 3,800 million m^3 are in the productive forest. This represents an average growing stock of about 73 m^3/ha, but wide ranges of stocking density exist depending on local conditions. The coniferous forests account for almost 750 million m^3 with densities per ha ranging from 60 m^3/ha in Nepal to 275 m^3/ha in Bhutan. Moreover, this sub-region also has a high proportion of managed forest, on average about 70 per cent, but over 75 per cent in India which explains the high degree of utilization of the forests. The total plantation area has reached 2.5 million ha, one third of which during the past 5 years alone.

Continental South-East Asia The continental South-East Asian subregion has a forest area of some 66 million ha of tropical forest, of which about 41 million ha are considered productive, with 3.5 million ha under management. Total growing stock in the closed forest is estimated at some 8,800 million m^3, of which 6,650 million m^3 are in the forests considered productive. This gives an average growing stock of some 160 m^3/ha. By 1980, the total plantation area had reached 350,000 ha, half of which was established during the previous 5 years. The area includes 70,000 ha of coniferous plantations in Vietnam.

Insular South-East Asia This subregion has Asia's most important forest resources both in volume and in quality. In total the area of closed forest in this subregion is estimated at some 148 million ha, which represents more than 55 per cent of the total land area. The coniferous forests cover some 500,000 ha, mainly in Indonesia and the Philippines. Approximately 111 million ha of forest is considered operable. Total growing stock is estimated at some 31,500 million m^3, of which some 21,000 million m^3 are in the productive forest with an average growing stock of about 200 m^3/ha. There is a strong, emphazis on plantation development. The total plantation area is estimated at 2.25 million ha, mainly in Indonesia and the Philippines. Some 40 per cent of the planting is in coniferous species.

1.2.4 Deforestation, afforestation and reforestation

The tropical forest resources are steadily decreasing; the annual deforestation rate for the period 1976-1980 amounts to about 0.7 per cent. According to FAO estimates for 1981-1985 more forests will be destroyed annually in tropical America than in other developing regions.[7] Due to the existing reserves, however, the situation is not as critical as in Africa or Asia. In general, deforestation is uncontrolled and usually does not conform to any land use plan.

Table 1.7. Annual deforestation in productive closed forests in relation to total productive forest area in tropical regions

	Total productive closed forest area mill. ha.	Annual deforestation in the productive closed forest mill. ha.	%
Tropical America	521	3.2	0.6
Tropical Africa	134	1.3	1.0
Tropical Asia	197	1.7	1.9
Total	852	6.2	0.7

Source: FAO. Wood Resources and Their Use as Raw Materials, op.cit., and FAO, Tropical Hardwood Resources, op.cit, Table I-2.1, p.29.

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[7] FAO, Wood Resources and Their Use as Raw Materials, op.cit.

The major cause of deforestation is spontaneous shifting agriculture. This is considered to be responsible for about 35 per cent of total deforestation in Latin America, 70 per cent in Africa and 50 per cent in Asia. Another important cause is conversion of forest land to extensive grazing which takes place especially in Latin America and East Africa. Beyond the annual loss of 7.5 million ha of closed forest another 3.8 million ha are lost in "other wooded land" of which 2.3 million ha in Africa. Though this disappearance of open wooded land does not directly affect the industrial wood potential, it is, however, a severe loss in the production potential of fuelwood and building poles, as well as a step further in the savannisation and sometimes desertification of the rural areas.[8/]

The impacts of degradation are similar to those of deforestation. The degradation results in a qualitative and quantitative reduction of the growing stock and its production potential. The main causes are considered to be bad logging practices, exploitation exceeding the yield of the forest, overgrazing and fires. The rate of degradation is estimated to be 4.0 million ha per year.

In the developing countries, annual losses of tropical closed forests of an area of 7.5 million ha compares to annual industrial and non-industrial plantations of 1.1 million ha. A "replacement ratio" indicating the ratio of deforestation plantation can be computed (see Table 1.8). This ratio is 1:8 in tropical America including Brazil, but only 1:33 when Brazil is not included.

Tropical moist forests on the average produce 3 to 4 m^3 of logs per hectare per year, of which only 0.5 to 2.0 m^3 are currently saleable. The plantation of tropical pines makes it possible to produce about 20 m^3 per hectare per year of homogeneous raw wood. The total area of established plantations has been estimated at 11.5 million ha in 1980 which is regarded to be inadequate.

[8/] Ibid.

Table 1.8. Annual rate of tropical forest plantations and deforestation. 1,000 ha

	Forest plantations			Deforestation	Replacement
	Industrial	Fuelwood	Total	(all closed forest)	ratio
Tropical America	283	252	535	4,400	1: 8
Tropcal Africa	64	62	126	1,300	1: 10
Tropical Asia	233	205	438	1,800	1: 4
Total	380	719	1,099	7,500	1: 7

Source: FAO, Wood Resources and Their Use as Raw Materials, op.cit. p.40.

Table 1.9. Established plantations in tropical developing countries, 1980 (million ha)

Region	Industrial	Non-industrial	Total
Tropical America	2.6	2.0	4.6
Tropical Africa	1.0	0.8	1.8
Tropical Asia	3.5	1.6	5.1
Total	7.1	4.4	11.5

Source: FAO, Wood Resources and Their Use as Raw Materials, op. cit.

1.3 Uses of forest resources

1.3.1 Pattern of utilization

The following review of the utilization of the world's productive forest resources shows the scant utilization of the forest for production of industrial raw material in the tropical developing countries. The world's production of all roundwood reached some 3 000 million m^3 in 1980, of which 40 per cent was produced in developed countries and 60 per cent in developing countries (see Table 1.10 below).

Table 1.10. The global use of wood, 1980
million m^3

	Developing countries		Industrialized countries	
Industrial roundwood	300		1,100	
of which:				
Log exports		40		30
Chemical wood pulp		10		100
Mechanical processing		100		600
Fuelwood and charcoal	1,500		100	
Total	1,800		1,200	

Source: FAO, Yearbook of Forest Products, 1980, 1982.

The distribution of global roundwood production corresponds roughly to the distribution of the resources. However, the bias towards production of fuelwood in developing countries is overwhelming. Of the production of industrial roundwood, on the other hand, only about 20 per cent was produced in developing countries.

A detailed analysis of the degree of utilization of the different forest types in the developing world, with separate consideration of the use of the coniferous species in the temperate and tropical zones, has been performed.[9/]. This is briefly summarized in Tables 1.10 and 1.11 and in the section below.

In the developing world, only 294 million m^3 of industrial roundwood were produced, one-third by countries in the temperate zone and two-thirds by those in the tropical zone, though the volume relationship between their respective growing stock is one to twelve.

9/ FAO, Wood Resources and Their Use as Raw Materials, op.cit.

Table 1.11 Roundwood production by development region, 1980 (million m^3)

Region	Total	Fuelwood	INDUSTRIAL ROUNDWOOD					
			Total	of which: conf.	of which: non-conif.	sawlogs and veneer logs	pulpwood	other industrial roundwood
Developed	1251	151	1100	872	228	651	312	137
Developing temperate	364	265	99	65	34	52	12	35
Developing tropical	1406	1211	195	30	165	139	17	39
Total developing	1770	1476	294	95	199	191	29	75
Total World	3021	1627	1394	967	427	842	341	212

Source: FAO, Wood Resources and Their Use as Raw Material, op.cit.

Table 1.12. Industrial roundwood production in tropical developing countries (million m^3)

	Total	Of which: Coniferous	Sawlogs and veneer logs	Pulpwood	Other industrial roundwood
Tropical America	63	26	45	12	7
Tropical Africa	41	3	21	2	18
Tropical Asia	91	1	73	3	15
Total Tropical Developing	195	30	139	17	39

Source: FAO, Wood Resources and Their Use as Raw Materials, op. cit.

A breakdown of the 1980 production of 294 million m^3 of industrial roundwood in developing countries indicates that this comprised 191 million m^3 of sawlogs and veneer logs, and 29 million m^3 of pulpwood used by forest industries, plus 75 million m^3 of wood for use in the round as poles, piling and posts. In the developing countries this last category is used extensively for building. In China, it represents almost 40 per cent of the total industrial roundwood production. In the other developing countries, at least in those with forest, it is probably of similar importance. Statistical data put 20 per cent of total industrial roundwood production in this category, but large volumes of this type of product are often not recorded. Moreover, such poles are also harvested outside the forest.

1.3.2 Non-industrial use of wood

Wood can be used simply for its energy value. In fact, that is its major use in the world, especially in the developing countries. This use disregards the structural or the fibre qualities of the wood. However, for about 2000 million people in the developing world, it is the major means of meeting their essential energy needs, most of which is simply the daily household needs for preparing food and drinks, some heating and some artisanal uses. In the rural economy, it is also an essential input for productive activities that benefit low income people in particular.

Growing of wood for production of energy on an industrial scale exists in various parts of the world especially in the developing countries where fuelwood is used for many industrial activities. These include the making of charcoal, bricks, pottery, mineral extraction, tobacco curing, processing latex and various food-processing activities based on drying.

1.3.3 Primary wood processing industries

The mechanical processing of wood involves the manufacturing of three categories of products; namely, sawnwood products (such as unplaned and planed sawnwood and railroad sleepers); peeled and sliced wood products (such as veneer and plywood) and reconstituted wood products (such as fibreboard and particle board).

World consumption of all mechanically processed wood increased by 8.9 per cent from 1970 to 1980, and except for Oceania and the U.S.S.R., every region recorded an increase over this period. The consumption of developing countries increased by 34 per cent. Moreover, the developing countries' share of the world consumption of products from the primary processing industry, which was only 12 per cent in 1970, increased to 17 per cent in 1980[10/].

An indication of the difference in consumption shares between industrialized and developing countries is given in Table 1.13 which shows the apparent consumption of selected mechanical wood products, by regions in 1980.

[10/] FAO, Yearbook of Forest Products, 1980, 1982.

Table 1.13 Apparent consumption of selected mechanical wood products by regions, in 1980 (1000 m^3)

Regions	Conifer. sawnwood	Non-conifer. sawnwood	Veneer	Plywood	Particle board	Fibreboard
World	317,918	102,647	5,090	39,156	40,467	16,266
Industrialized:						
Noth America	87,952	18,700	441	18,624	7,728	6,329
Europe	75,804	22,006	2,198	5,192	23,911	4,639
U.S.S.R.	80,364	12,632	527	1,723	4,428	2,705
Oceania	3,114	2,419	66	184	665	227
Japan	35,595	6,894	300	8,402	1,024	564
Percentage of total	89	61	69	87	93	89
Developing:						
Africa	3,370	5,430	189	573	447	157
Central America and Caribbean	1,907	1,110	25	504	482	106
South America	8,552	11,148	202	899	919	740
Asia	21,260	22,308	1,142	3,055	863	799
Percentage of total	11	39	31	13	7	11

Source: Derived from FAO, Yearbook of Forest Products, 1980, 1982. Data exclude railway sleepers.

The total consumption of all the mechanical wood products in the developing regions increased over the decade of the seventies. This holds particularly for non-coniferous sawnwood, veneer and plywood. In 1970, the share of developing countries in total world consumption of these products was 29 per cent, 13 per cent and 7 per cent respectively. Whereas in 1980, this share had increased to 39 per cent, 31 per cent and 13 per cent respectively. South America and Asia accounted for the overwhelming share of this increase in consumption[11].

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[11] For a detailed analysis of the consumption of different types of sawnwood as well as of panels. see FAO, Wood Resources and their Use as Raw Material, op. cit.

1.3.4 Secondary wood processing industries

Secondary wood processing covers the transformation of sawnwood and panel products (semi-finished products) into a finished product. The main uses of secondary wood processing products are:

Structural
- temporary works
- frames and trusses
- prefabricated elements

Non-structural
- furniture
- joinery

Other
- packaging
- pallets
- miscellaneous wooden articles.

Often the smaller factories combine the manufacture of furniture and joinery products.

Data on the secondary wood processing in developing countries are scarce and unreliable. However, it is overwhelmingly clear that secondary wood processing is not developed to its full potential. As will be shown in Chapter 3, developing countries have a trade deficit in many secondary wood products. In world exports, developing countries account for only 8-10 per cent.

1.3.5 Wood for chemical processing

The suitability of various species of wood for the pulp and paper industries is mainly determined by the characteristics of the fibre. The most important characteristics are fibre length and fibre flexibility. At present, chemical wood processing is limited in the developing countries, owing to characteristics of the available raw material as well as to other input constraints such as capital and skills, and size of the domestic market.

In the tropics, experiments are going on with quick-growing species for producing pulp. If, successful results are obtained, it is expected that production of pulp will increase substantially in the tropical countries, leading to strong competition with traditional pulpwood suppliers.

The world production of pulpwood in 1980 was 341 million m^3 of which 92 per cent was produced in the industrialized countries, only 3 per cent in the developing temperate region, and 5 per cent in the developing tropical region. Most of the pulpwood production in the developing tropical regions came from tropical America. Brazil has considerably increased its share of production of pulp and paper, and several developing countries have started setting up their own pulp and paper industries.

1.3.6 Miscellaneous products derived from wood

In addition to sawnwood, panels and paper there are other commercial products derived from wood. Chemical feedstocks derived from wood are used in the production of adhesives and coatings, viscose rayon, and other products.

The carbohydrates available in unprocessed wood are not digestible by ruminants but can be made so by steaming, providing a potentially significant source of food for livestock. Other products which are produced from wood include tannin, turpentine, creosote, producer gas (a low calorie gas which is suitable for use in internal combustion engines), activated charcoal, furfural and alcohol.

The most important source of most of these products is the pulp and paper sector, which creates waste material by chemical and thermal processing of wood. In many cases, the chemical recovery processes are profitable. Often, however, the incentive for processing wastes results from the fact that since there are environmental regulations which prohibit their free disposal it is more efficient to convert wastes into commercial products than to dispose of them in a way that complies with environmental regulations.

The economic importance of these miscellaneous products is less for both their indirect production from logs (or other parts of the tree) and as by-products of mechanical processing. However, waste material from mechanical processing (especially if the definition of waste is broadened to include material left in the forest) constitutes a vast amount of raw material that could be used for the products mentioned above as well as for the uses discussed elsewhere in this report (viz. particle board, fibreboard and energy production). For example, the processing of wood for animal food can be accomplished through steaming and does not require a large capital outlay. Also as energy prices increase, the production of fuels such as alcohol and producer gas could become a more widespread use of the forest biomass.

1.4 Perspectives towards the year 2000[12]

1.4.1 Development potential

It is estimated that world roundwood production would increase from 2,800 in 1975 to 3,910 million m^3 in the year 2000, an increase of some 40 per cent, and this would come from a rise of about 400 million m^3 in the developed market economies, some 300 million m^3 in the centrally planned countries, and a further 400 million m^3 in the economies of the developing world. This would mean increases of 53 per cent for the developed market economy countries, 41 per cent for the centrally planned economy countries and only 31 per cent for the developing countries, even though these last mentioned countries have some 58 per cent of the world forest resources. This projected increase has been broken down into its fuelwood and industrial wood components in Table 1.14.

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[12] This section is based on material contained in FAO, Forestry Paper No.29 "World Forest Products - Demand and Supply 1990 and 2000", 1982.

Table 1.14 World roundwood production, 1975 and 2000 (million m^3)

Region	1975			2000		
	Total roundwood	Fuelwood	Industrial roundwood	Total roundwood	Fuelwood	Industrial roundwood
Developed market economies	761	57	704	1 165	70	1 093
N. America	454	18	436	670	28	642
W. Europe	229	29	200	350	30	320
Oceania	22	1	21	60	2	58
Japan	37	-	36	58	-	58
Other	19	8	11	25	10	15
Developing market economies	1 305	1 112	193	1 715	1 350	365
Africa	327	294	33	360	300	60
Latin America	309	250	59	525	400	124
Far East	582	495	87	760	600	161
Near East	87	73	14	70	50	20
Centrally planned economies	733	304	429	1 030	400	627
USSR & Eastern Europe	468	96	372	630	100	531
Asia	265	208	57	400	300	96
World	2 799	1 473	1 326	3 910	1 820	2 085

Source: FAO, "World Forest Products - Demand and Supply 1990 and 2000"; Forestry paper No. 29, Rome, 1982, Table 2.0.

Note: Totals may not add up due to rounding.

The FAO evaluation estimates that the world production of roundwood for industrial processing might increase over the last quarter of this century by some 750 million m^3, or 57 per cent above the 1975 production level. This increase would be from some 390 million m^3 in the developed market economies, 200 million m^3 in the centrally planned economy countries and some 170 million m^3 in the developing market economy countries, and would mean for these three country groupings increases of 55 per cent, 46 per cent and 89 per cent respectively.

The study estimates that consumption of manufactured wood products would increase by about 63 per cent (including increasing use of wood residues and more efficient manufacturing). It also expects an increased consumption of wood products of some 140 per cent in the developing market economies, as well as a virtual doubling of net wood exports. This net wood export trade in value would consist of 45 per cent of processed wood (mostly primary products) as against 22 per cent in 1975.

Table 1.15 presents a broad picture of the prospective additional sources of supplies of industrial sawnwood. Additional sources of supplies in the tropical countries are evaluated at some 80 million m^3 of hardwood logs and 95 million m^3 of pulpwood, slightly more than half of which would be hardwoods.

The tropical closed forest is expected to be reduced by some 12 per cent largely due to clearing for agriculture, but utilization is expected to increase the total output both by extending the species range and by opening up as yet unutilized areas.

In the tropics, plantations are expected to increase from some 5 million ha to over 16 million ha by 2000 and the supply of industrial wood to increase tenfold to reach some 100 million m^3. Latin America is expected to account for about two-thirds of the tropical countries' supply of industrial wood from plantations, more than 60 per cent of which is likely be coniferous wood.

Table 1.15 Roundwood for industrial processing 1975 and 2000
Perspective additional suppliers
(million m^3)

	1975	2000	Annual percentage change	Main additional suppliers
Broad-leaved logs	220	320	1.5	tropical countries + 80
Coniferous logs	570	862	1.7	(U.S.S.R.+ 85, North America + 65) (Europe + 20, Japan + 20)
Total logs	790	1,182	1.6	
Pulpwood and miscellaneous	540	903	2.3	(North America + 110, Europe + 100) (Tropical countries + 95)
Total	1,330	2,085	1.8	

Source: FAO, Wood Resources and Their Use as Raw Material, op. cit.

On a world basis, wood supplies are judged to be sufficient to meet the prospective demand in the year 2000 if the supply potential in the various regions can be fully realized. This is shown, on a product basis, in Table 1.15 above. However, regionally there are, and will continue to be, differences between production and consumption as shown in Table 1.16 below. Both Western and Eastern Europe as well as Japan will continue to consume more wood products than what they produce, as will the wood-poor areas in the Middle East and North Africa. The major excess production regions will continue to be North America and the USSR with smaller surpluses coming from Oceania and the Far East. Latin America, although its production is expected to increase substantially, will maintain a reasonable balance between production and consumption due to a projected substantial increase in its consumption of wood products.

The ability to supply these increased demands for timber would be increased by making greater use of currently commercially less accepted species.

Table 1.16 World consumption[a] of wood products by product group, 1960 to 2000 (millons m^3)

Product group	1960	1970	1980	1990	2000
Softwood					
Sawnwood and sleepers	252.1	300.6	329.5	368.6	399.4
Solid wood panels	10.0	18.7	24.3	30.6	34.5
Reconstituted panels	12.0	35.0	61.4	81.0	100.7
Other industrial products	74.4	66.9	68.5	67.7	67.7
Pulps	187.6	314.0	379.5	477.3	631.0
Total softwood	536.1	735.2	863.2	1,025.2	1,233.3
Hardwood					
Sawnwood and sleepers	73.5	91.2	99.3	123.9	143.1
Solid wood panels	6.8	17.3	24.1	29.6	35.0
Reconstituted panels	7.2	19.9	32.9	44.1	55.2
Other industrial products	69.4	77.3	81.5	83.6	88.3
Pulps	39.8	91.7	132.0	187.1	263.6
Total hardwood	196.7	297.4	369.8	468.3	585.2

Source: FAO, World Forest Products Demand and Supply 1990 and 2000. FAO Forestry Paper 29, Rome, 1982, Table 2.0.

a/ World consumption is assumed to equal production in each product category.

Table 1.17 World consumption and production of wood products by region[a], 1960 to 2000
(million m^3, fibre volume[b])

Region	1960			1970			1980			1990			2000		
	Consumption	Production	Net import(-) or net export(+)	Consumption	Production	Net import(-) or net export(+)	Consumption	Production	Net import(-) or net export(+)	Consumption	Production	Net import(-) or net export(+)	Consumption	Production	Net import(-) or net export(+)
Market economies															
North America	235.4	240.7	+5.3	333.1	353.0	+19.9	392.2	415.2	+23.0	459.4	485.6	+26.2	538.7	575.1	+36.4
Western Europe	148.0	142.4	-5.6	226.4	207.6	-18.8	264.6	243.5	-21.1	313.0	280.6	-32.4	369.1	325.7	-43.4
Japan	46.8	46.0	-0.8	88.7	80.8	- 7.9	102.0	93.0	- 9.0	132.9	114.6	-18.3	168.8	136.8	-32.0
Latin America	20.0	18.6	-1.4	34.8	33.0	- 1.8	43.9	44.4	+ 0.5	64.5	71.0	+ 6.5	96.5	103.6	+ 7.1
Oceania	10.0	8.6	-1.4	12.4	10.8	- 1.6	16.1	14.5	- 1.6	20.7	20.9	+ 0.2	28.7	36.4	+ 7.7
Middle East and North Africa	8.2	6.3	-1.9	10.3	7.4	- 2.9	13.1	8.5	- 4.6	16.8	10.9	- 5.9	22.9	15.5	- 7.4
Africa South of the Sahara	14.9	14.9	0.0	23.1	24.5	+ 1.4	29.5	31.2	+ 1.7	36.2	40.6	+ 4.4	44.3	53.2	+ 8.9
Centrally planned economies															
Far East	19.3	20.3	+1.0	27.0	28.7	+ 1.7	38.8	43.8	+ 5.0	60.4	70.6	+10.2	82.8	99.3	+16.5
Eastern Europe	41.7	41.1	-0.6	52.0	51.2	- 0.8	68.8	63.6	- 5.2	85.6	71.9	-13.7	107.5	79.4	-28.1
USSR	157.1	162.3	+5.2	183.0	193.6	+10.6	209.0	220.2	+11.2	239.1	261.0	+21.9	279.5	313.8	+34.3
Asia	31.5	31.6	+0.1	41.9	42.0	+ 0.1	55.0	55.1	+ 0.1	65.7	65.6	- 0.1	79.7	79.6	- 0.1
World	732.8	732.8		1,032.6	1,032.6		1,233.0	1,233.0		1,493.4	1,493.4		1,818.5	1,818.5	

Source: FAO, World Forest Products, Demand and Supply 1990 and 2000; FAO Forestry Paper 29, 1982, various tables.

[a] Wood products have been combined into five product groups: sawnwood and sleepers, "solid wood" panels, reconstituted panels (particleboard and fibre board), other industrial products (pitprops and other industrial roundwood), and pulps (mechanical, semi-chemical, chemical, and dissolving).

[b] These figures are in terms of cubic meters of "fibre volume", which is the amount of unbarked wood per reported measure of product volume.

CHAPTER 2. Logging and Transport[13/]

2.1 The role of logging and transport in overall forest management

Logging and transportation systems have a very great impact on overall forest management policy. They affect nearly all aspects of both the biological and physical systems as well as the economic aspects of the land management system. The appropriate technological methods in these key areas will in a large measure determine the success of the forestry and the wood products industry as a contributor to economic development. The discussion in this chapter is confined to logging in relation to the institutional arrangements for granting forest utilization rights and the engineering and economic aspects of various types of logging systems. By the transport system is meant the roads and equipment which are used to transport logs from stump to the main transport system.

The effects of various harvest regimes and associated logging systems on the future productivity of the tropical forest are not known with the same degree of precision as for the temperate and especially the temperate coniferous forest. These relationships are an area of active research and no doubt will be better understood over time. But future timber yields are not the only consideration in choosing logging and transportation systems. Other important considerations are the overall environmental effects and the ability of the logging operations to support local processing operations. Clearly the management of these two aspects have an overall effect on the contribution of the forestry and wood products industry to economic development. Beyond these considerations is another often equally important consideration relating mainly to those areas where the forest lands in question are under public ownership, namely the government's ability to collect the full value of the rents associated with harvesting the timber.

[13/] This chapter is based on FAO, Wood Resources and Their Use as Raw Material, op. cit., Chapter 1, and N.A. Burdin and V.A. Sylantyev, op. cit.

As stated above the logging and transportation systems in the broadest sense encompass a wide variety of forest management activities. Logging in its broadest definition includes the institutional arrangements associated with forest utilization, the harvest method (i.e. selection cutting or clear cutting or some hybrid of the two), the regeneration method (i.e. natural regeneration, plantation, abandonment, or conversion to other use), the logging method (i.e. the type of equipment, such as tractor, skyline or other cable system, animal and so forth), the scheduling of the harvest, and a number of other considerations. The transportation system includes both the forest transportation system and the transport system which takes logs from some intermediate point to their final destination. This distinction can be best made by restricting the forest transportation system definition to include the road network and equipment necessary to bring logs out to the main road, rail or water transport network. This also means that it must serve the function of enabling the appropriate equipment to get to the logging area. Even so the distinction is not always so clear. In fact, mobile or semi-mobile sawmilling facilities may be brought to the harvest area (or to the general area to be logged). In some cases roads built to service a particular logging operation may become main roads after logging operations are complete.

In industrialized countries the level of mechanization in all phases of logging operations can be very high. In the Soviet Union the trend is toward comprehensive mechanization of all logging operations with the final purpose of the total exclusion of manual labour. Use of modern equipment such as felling and delimbing machines together with tree-length hauling minimizes the operations which have to be carried out at the felling site, and greatly increases labour productivity.

2.2 Types of forest utilization arrangements

Forest utilization arrangements on lands in the public domain are of two types: timber harvesting contracts and forest management contracts. The former usually run for a shorter term. Timber harvesting contracts usually grant the right to harvest trees in a certain area and stipulate that certain conditions will be met. These conditions may include logging methods, road construction standards, and other factors which affect the long-term productivitiy of the forest. Royalties are normally based on the volume and sometimes grade of timber removed.

Long term forest management contracts have been successfully used in developing and developed countries. The principal advantage of this type of contract lies in the tendency for the forest management concern to manage the forest in a way that ensures its long-term productivity since the firm will have an interest in future harvests. However in order for these contracts to be successful it is essential that certain minimum standards of management for environmental effects as well as other considerations be stipulated in the contract in order to ensure the overall social interest is served. This is particularly the case where the forest lands are expected to contribute to the production of goods and services other than timber, for example wildlife habitat, watershed protection and recreational use (see section 1.1 above)

2.3 Logging Methods

There are a wide variety of logging methods and the selection of the optimal system depends on the type of forest and on the objectives of forest management, on terrain and climate, and on economic considerations. The main types of logging systems are:

- multi-processor systems;
- mechanical ground skidding;
- cable systems and aerial systems;
- other mechanical systems;
- manual or animal systems.

Multiprocessor systems use a single machine for several or all of the stump-to-truck operations. This can include felling, limbing, bucking, hauling the material to the truck and loading it on. This system requires that the terrain not be too steep. It is most widely used in developed countries.

Mechanical ground skidding is the term used to describe the system where logs are dragged behind wheeled or tracked vehicles. The system is used in most forest regions of the world.

Crawler tractors can operate on slopes up to 40 or 50 per cent favourable grade and 10 to 20 per cent adverse, but ground travel by crawlers is relatively slow. Articulated wheeled skidders can operate on slightly lower slopes - 30 to 35 per cent favourable grades - and are designed for fast hauling. Although either may be used alone, in tropical forests crawlers and skidders are frequently used in combination with one to three tractors gathering logs over short distances for one skidder. The skidder then drags the logs for distances up to 1.0 to 1.5 kilometers to roadside. In this manner logs can be moved quite rapidly over substantial distances and expensive road construction can be kept to a minimum. While it is fast, a wheeled skidder is quite sensitive to adverse grades and loses effectiveness significantly in broken ground. Similarly, productivity is lost in very wet ground.

Ground skidding is particularly well suited to partial cutting in tropical forests as vehicles can be manoeuvred among the standing trees with relative ease. In some South American forests, extraction of volumes as low as 15-20 m^3/ha has been found profitable.

Crawler tractors have been in use for many years for various purposes, and men experienced in their use can be found in most countries. This degree of familiarity simplifies training of operators for tractors and skidders in logging. Still, trained and experienced planners and supervisors are required to attain an efficient operation and to avoid silvicultural and environmental damage.

Cable systems are those systems which involve the use of moving lines; a winch which is stationary while in service and one or more spars or masts to give elevation. Logs are either partially or entirely off the ground as they are moved. Many variations exist, of which "high lead", "skylines" and "cable cranes" are primary examples. In the high lead system, the winch and spar are frequently mounted on wheels or tracks to form a "mobile yarder". In the Philippines, wooden spar trees are still being rigged in some locations.

Heavy duty cable systems are in use in western North America, the Philippines, and Borneo. Lighter systems are in use in mountainous regions of Europe and some developing countries in Latin America and Asia. Very light systems are now being developed for use in small timber and thinning operations in North America, Europe and Japan.

Cable systems are essential where logging is carried out on steep slopes or in swampy areas. The sensitivity of soils to compaction may also favour the use of cable systems over ground systems, though animal and manual systems may be viable alternatives under these conditions. The future productivity of the forest must also be considered in the selection of logging systems, for example, the extent to which soil compaction which would result from the use of mechanical ground skidding might preclude reforestation. On forested areas with high values as wildlife habitat, watershed protection, or unique ecosystems, logging methods will need to be selected which do not unduly raise the risk that the future forest productivity will be sacrificed. An alternative to the use of cable systems are various types of aerial systems (helicopter and lighter-than-air craft), which can be used in various terrains and are generally suitable for environmentally sensitive areas.

While aerial and cable systems usually result in lower road costs per unit of timber volume removed, their overall cost is normally higher. The use of cable system is also normally restricted to areas where high timber volumes per hectare can be harvested because of the expense required to set up the rigging for this system. Helicopter logging in North American has been used for harvesting high value trees in selection harvests with very low volume per hectare. It is also used, on an experimental basis, in the Soviet Union.[14]

In developing countries the availability of skilled technicians necessary to set-up and operate cable and aerial systems may also result in higher operation costs in relation to other logging systems.

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[14] N.A. Burdin and V.A. Sylantyev, op. cit.

While animal logging systems are generally not considered practical in industrialized countries, they represent an important alternative to both mechanical ground skidding and cable operations in cerrrain developing countries. Still it should be emphasized that while there is a great deal of this type of logging in many developing countries, it does not represent a large share of total volume of timber logged worldwide, nor even for total volume in developing countries.

The types of systems included in "other mechanical systems" include simple logging methods that are most suitable for areas which are easily accessed and can be logged with very simple equipment such as farm tractors and specially adapted trucks. An advantage of these systems is that they do not require special purchasing or servicing arrangements. While not suitable for logging in difficult terrain, they can be used effectively under appropriate conditions.

Some systems depend very heavily on manpower to produce logs. Many push or pull, roll or slide, throw or carry, logging operations still exist which may produce logs cheaper than mechanized operations under appropriate conditions. An excellent example is the Kuda Kuda system used in Borneo to harvest forests in freshwater swamps. Under this system, men are harnessed to the logs and pull them over a skid-way to a light railway where they are loaded, again manually, onto rail cars. A 1981 report shows a total cost of US$19/$m^3$ for all phases of the operation.[15]

Other systems depend on animals. Some small operations in developed countries still use horses. Malawi is training oxen to skid logs. Elephants, buffalo and bullocks are still used extensively in Asia. Reports from India show that a pair of buffaloes can move 2 to 3 m^3/day over 500 m at a cost of US$0.90 - US$1.00/m^3. An elephant can move 6 to 8 m^3/ day over a similar distance at a cost of US$2.50 - US$3.25/m^3. It can load 40 - 50 m^3/day at a cost of US$0.40 - US$0.55/m^3.[16]

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[15] FAO, Wood Resources and Their Use as Raw Materials, op.cit.

[16] Ibid.

2.4 Transportation systems

The forest transportation system normally involves skidding logs to a point where they can be loaded for further transport by road, rail or water transport system. Cable logging systems involve pulling logs to the forest road system via the cable system for loading on to trucks. The use of cable logging systems requires fewer roads but the roads may have to be built to a standard that allows the cable system to be transported to the logging site.

The most efficient means of transporting logs over long distances depends on the particular circumstances surrounding the logging operation. If water or rail facilities are available they are much cheaper on a per unit per kilometer basis, but offsetting this is the fact that logs have to be unloaded and reloaded. One of the major problems associated with the development of primary processing in many regions is the problem associated with ensuring a sufficiently even flow of raw material inputs over a long period. The source of this problem is not the lack of adequate forest resources and the ability to supply a steady flow of logs from the forest but the difficulties in transporting these logs to the mill site. This emphasizes the need for focusing attention on the main transport systems.

Due to the many different conditions and situations facing forestry and logging operations, logging costs vary significantly even within a specific region or even for similar forest types. The main factors which affect logging productivity and costs, in addition to logging technique, are such items as forest type (species, volume per area unit, size of logs), terrain, climate, experience of personnel and social or cultural traditions.

CHAPTER 3. Possibilities and prerequisites for mechanical wood processing industries in developing countries

As part of a resource based industrialization strategy, transformation of forest resources into products of higher value is an attractive possibility for many developing countries with large areas of forest. These forest areas have been reviewed in chapter 1. The present chapter first presents some rough indicators of certain macro-economic characteristics showing that mechanical wood processing industries generally should be very suitable for the developing countries. The chapter goes on to discuss some technical characteristics, the particular prerequisites that must be met and the constraints that must be overcome for the developing countries to resolve the problems successfully and to exploit their natural advantages in this industry. The role of the industry in the development process will be discussed in chapter 5 and the particular measures that need to be taken in order to develop local and foreign markets for the products are discussed in chapter 6.

3.1 Comparative advantages of developing countries in mechanical wood processing

The wood processing industry requires various input factors, such as raw material, labour, energy, capital, management, transportation, services, and markets. Many developing countries enjoy a comparative advantage over most of the industrialized countries, with regard to wood and manpower resources.

On the other hand, a majority of developing countries lack, for instance, skilled manpower, capital and infrastructure. Therefore, neither the domestic processing of logs nor of primary products has yet developed to its full potential.

Table 3.1 shows some key economic indicators for selected countries. Whereas the operations tend to be very large in the centrally planned economies, the parts of wood processing industry, in particular sawmilling and secondary processing, in industrialized market economy countries is characterized by predominance of small firms, although large operations certainly exist, too.

Table 3.1. Key economic indicators of selected countries for total manufacturing (ICIS 3) and primary wood processing industries (ICIS 331)[a]

	No.employees/ establishment 1978		Wages and sal./empl. US$ current 1979		GFCF[b]/ / empl. US$ current 1978		Value added/ empl. US$ current 1979	
	3	331	3	331	3	331	3	331
Low income countries								
India	77	21	662	335	...	...	...	...
Indonesia	102	84	675	713	780	910	...	...
Kenya	286	157	...	...	...	...	4,639	1,393
Middle income countries								
Brazil	48	27	2,020	1,220	1,477	977	...	...
Ivory Coast	112	113	3,912	2,393	...	...	7,237	3,138
Yugoslavia	236	175	3,098	2,805	2,498	2,134	8,079	5,731
Industrialized countries								
Austria	94	38	10,433	9,610	2,833	2,421	19,107	20,532
Canada	56	34	12,991	13,412	2,679	2,349	19,613	20,532
Sweden	80	39)	12,720	11,680	3,161	2,892	21,931	22,601
Centrally planned economies								
Czechoslovakia	...	...	5,543	3,199	2,686	2,741	9,803	8,652
Poland	121	103	...	...	...	...	10,904	8,400
U.S.S.R.	856	1,037	2,503	2,662	1,511	1,132	10,878	5,567

Source: UNIDO data base

a/ Figures as a rule refer to 1978-79, but some figures particularly for wages and salaries refer to 1977 or earlier years. This approach does not in any way affect the conclusions drawn from this table.

b/ Gross fixed capital formation

It is interesting to note that in the selected developing countries except India the number of employees per establishment is considerably larger than in the selected industrialized market economy countries. The underlying statistical analysis shows that in most developing countries the wage level in wood processing industries is lower than in total manufacturing industries and that this is also valid for investment per employee and for labour productivity. For most of these variables, as can be seen in Table 3.1, the values for the developing countries selected are considerably lower than for most of the selected industrialized countries. Thus the wood processing industry is characterized by lower wages, higher intensity of labour and substantially lower direct capital requirement than total industry. These figures indicate that, generally speaking, developing countries would have a strong competitive advantage over the industrialized countries in this industry provided the lower productivity can be overcome. They also indicate that the wood processing industry could be a priority sector in the industrialization of the developing countries.

The above indications and figures are very scanty and have mainly illustrative value. However, they tend to indicate that developing countries ought to have a competitive edge in this industry. Nevertheless, this potential is incompletely utilized.[17/]

For the following analysis[18/] of comparative advantage, only the following wood products are considered: shaped or simply worked wood (e.g., sawn and planed sawnwood), plywoods and veneers, and products manufactured chiefly of wood. Products such as furniture, which are manufactured using substantial non-wood materials, are not included. Neither pulp and paper, nor fuel are considered.

[17/] For a complete analysis including a theoretical discussion and presentation of the concept of revealed comparative advantages with an application to the wood processing industries, see UNIDO/IS, Industrial Development Survey 1983, Chapter 6 (forthcoming).

[18/] UNIDO/IS, Industry in a Changing World, Industrial Development Survey, Chapter XII (forthcoming), Division of Industrial Studies, Statistics and Survey Unit.

The allocation of world production and consumption is reported in Table 3.2 [19/]. These data reveal a very high correlation between the consumption of wood products and production. Developed market economies in the higher income group account for roughly 80 per cent of world consumption. Net imports are a relatively small proportion of consumption, roughly 2.5 per cent. The developing countries, as a group, are net exporters of wood products, exporting roughly 6 per cent of their production. However, a number of these countries must supplement domestic production with substantial imports.

In value terms, the dominant producers of wood products are Canada, the EEC, Finland, Japan, Sweden, and the United States[20/]; all of which have large indigenous supplies of natural raw materials. Together, they account for over three-fourths of all production carried out in the developed market economies and the developing countries. Major producers in the developing countries include Chile, Brazil, India, Malaysia, Mexico, Philippines, Republic of Korea and Indonesia.

Thus there is little doubt about the primary source of comparative advantage in the wood products industry: this industry is raw material based and most of the major exporters have substantial natural forests. There are a few countries, however, that base their wood products industry on significant imports of sawlogs. Major exporters, Canada and the United States are essentially self-sufficient in raw materials although both countries import roughly one-sixth of the wood products they consume. Other major exporters (Austria, the EEC, and the Scandinavian countries) also import sawlogs that account for roughly 6 per cent of the value of their outputs of wood products.

[19/] Because of data problems, the analysis of comparative advantage excludes the centrally planned economies.

[20/] The USSR and Chechoslovakia would also be among the major producers had data been available to include them in the analysis.

Table 3.2 Production, trade and consumption of wood products[a], 1977[b]
(million dollars)

Country Group	Gross Output	Imports	Exports	Apparent Consumption	RACGO[c]
Developed market economies: higher income group	80133	10467	9040	81560	1.018
Developed market economies: lower income group	4448	349	488	4309	0.969
Semi-industrialized developing countries: higher income group	3924	276	918	3282	0.836
Semi-industrialized developing countries: lower income group	1733	219	824	1128	0.651
Developing countries: higher income group	1013	171	282	902	0.890
Developing countries: middle income group	258	28	92	194	0.752
Developing countries: lower income group	193	5	24	174	0.902
Asian subcontinent	247	7	24	230	0.931
Least developed countries	128	32	9	151	1.180
More industrialized oil exporting developing countries	900	396	104	1192	1.324
Modestly industrialized oil exporting developing countries	146	603	63	686	4.699

Source: UNIDO Secretariat calculations and data supplied by United Nations Statistical Office.

a/ For a definition of "wood products" in this context, see text on page 47

b/ 1977 was chosen for data reliability reasons.

c/ RAGCO = Apparent consumption/gross output.

Japan, Singapore, the Chinese Province of Taiwan, and the Republic of Korea are the major exporters of wood and wood products that base their domestic industries on imported raw materials. Korean imports of rough wood account for an estimated 73 per cent of the value of gross output of wood and wood products, while Japan's imports are equivalent to 24 per cent of gross output. One-half of the supply of these raw material imports originates in North America, and one-half in the ASEAN countries.

The volume of exports *per se* does not measure the degree of comparative advantage enjoyed by a country. It is possible, however, to identify countries that enjoy an international comparative advantage by examining alternative indicators. The relationships between production, consumption and trade are plotted in Figure 3.1[21/]. The vertical line represents gross output = 100; points 'N' and 'C' represent, respectively, new supply and apparent consumption as percentages of gross output[22/]. Countries for which 'C' lies to the left of the vertical line are net exporters and, therefore, are presumed to enjoy a comparative advantage. Countries for which 'C' lies to the right of the vertical line are identified as not having a comparative advantage. Countries for which 'C' and 'N' lie very near the vertical line are considered essentially self-sufficient, i.e., they are neither importers nor exporters.

Figure 3.1 permits the subdivision of the countries into three groups: 27 countries are identified as enjoying a comparative advantage, 12 are essentially self-sufficient, and 42 are mainly dependent on imports for a significant share of their domestic consumption. The aggregate exports of these three country groups were in 1977, respectively, $6,302 million, $156 million, and $1,709 million. It is interesting to note that of 21 major exporters several are indicated as not having an overall comparative advantage

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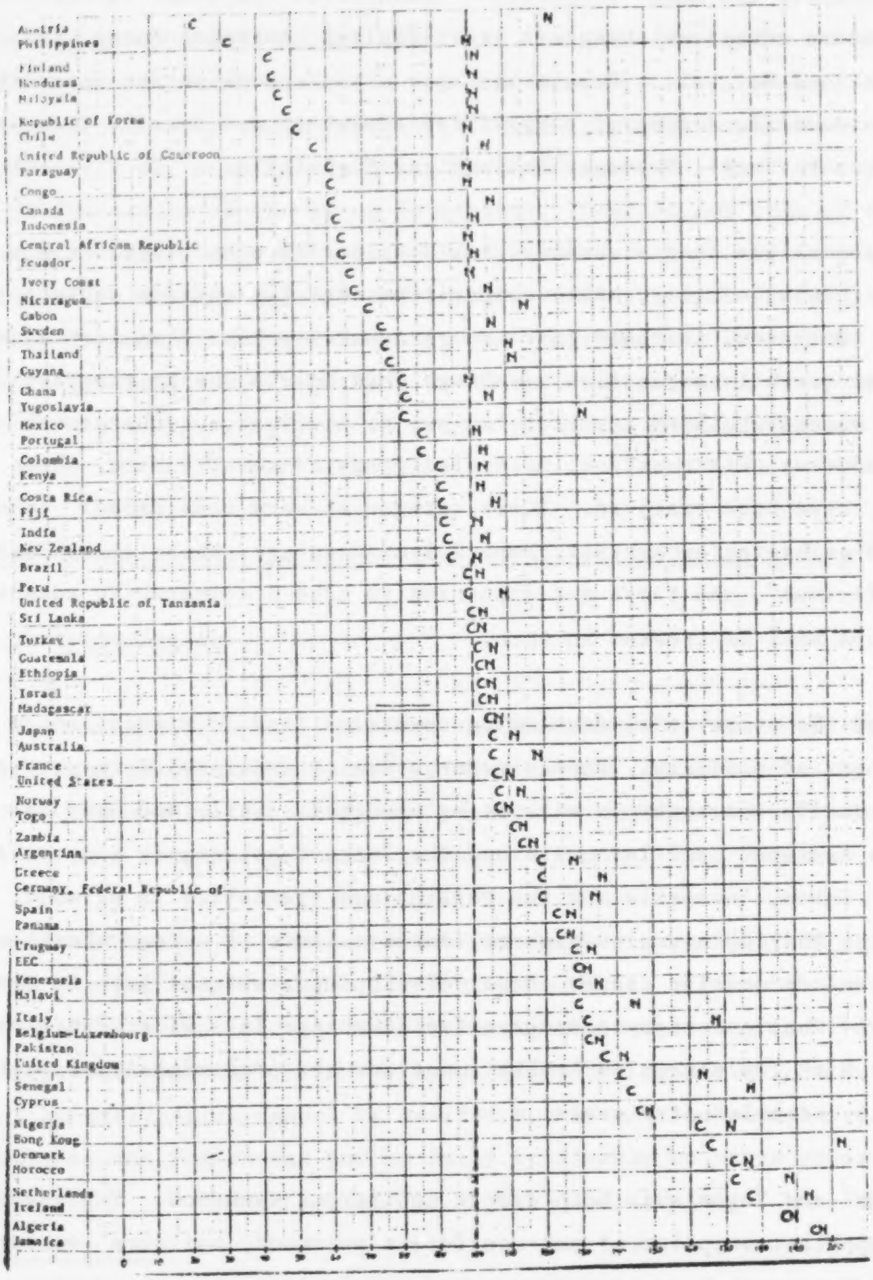
[21/] As Figure 3.1 is based on the situation prevailing in only one year, 1977, and since there may exist anomalies in the data, the placement of individual countries may appear odd. However, the overall impression is less fraught with such imperfections.

[22/] New supply is measured as gross output plus imports; apparent consumption is gross output plus imports minus exports.

Figure 3.1. Indexes of consumption (C) and new supply (N) of wood products (Gross output = 100)[a/]



Source: UNIDO Secretariat and data supplied by UN Statistical Office, New York.

a/ Because of scaling problems a few countries have been deleted from Figure 3.1. For example, Saudi Arabia is excluded because of the very large share of imports in domestic consumption ('C' and 'N' both lie very far to the right of the vertical line). Also, the very large entrepot trade for Singapore makes comparisons of production, consumption and trade meaningless.

in this industry; these include Australia, Japan, Norway, Spain, the United States. Only 13 of the major exporting countries are found to enjoy an overall comparative advantage; and only six of these countries can be regarded as among the top ten most "competitive" countries. In order of their degree of comparative advantage these six are: Finland, Austria, Korea, Canada, Ivory Coast and Malaysia. Remaining major exporters which are indicated as enjoying a moderate degree of comparative advantage are Brazil, Indonesia, Philippines, Portugal, Sweden, Thailand and Yugoslavia.

It is possible that a country that does not have an overall comparative advantage in the industry, has a competitive edge in a narrow subsector of the industry. Moreover, in those cases where countries have been identified as enjoying an overall comparative advantage this may be due to the fact that they have an overwhelming advantage in one or more narrow subsectors. In order to address this question, more disaggregated country data, when available, have been examined. Three categories were considered: countries classified as having an overall comparative advantage, those identified as "self-sufficient", and those not appearing to have a comparative advantage. These groups will be treated in turn.

Most of the competitive developing countries tend to specialize in rather narrow ranges of products. Korean exports are concentrated mainly in plywood with some coniferous sawnwood also being exported. Chile and Honduras export coniferous sawnwood, and Indonesia and the Ivory Coast supply non-coniferous sawnwood. Gabon, Indonesia and the Philippines specialize in plywood, although the Philippines also exports lesser volumes of veneer sheets and household and decorative items. Other developing countries such as Brazil, Malaysia and Thailand enjoy a comparative advantage in a wider range of products. With few exception, these countries are predominantly exporters with little intra-industry trade.

Portugal and Yugoslavia both export coniferous sawnwood. Yugoslavia is also an important supplier of non-coniferous swanwood, builders' woodwork, plywood, and veneer sheets and is engaged in significant amounts of intra-industry trade, especially in coniferous sawnwood, plywood and veneer sheets.

The next group includes the countries that were identified as essentially self-sufficient. In total these countries exported $156 million of wood and wood products during 1977.

The third group comprises the countries that are identified as not having an overall comparative advantage in wood and wood products; most of these countries are extremely small exporters (their aggregate exports were $46 million or 4 per cent of the group's total exports). The trade pattern of the EEC is indicative of the group in general. Over 70 per cent of their exports are to other member states. And the bulk of the trade is heavily two-way, i.e., a country exports and imports similar items, except for where one country happens to enjoy an unambiguous comparative advantage in a certain specialized product group, but trade in these items accounts for only a small fraction of any member-country's exports of wood and wood products.

3.2 Major characteristics of mechanical wood processing industries[23]

3.2.1 Introduction

The following section will present certain characteristics of the main mechanical wood processing industries, particularly, with respect to raw material requirements, technology and marketing requirements. The major constraints that developing countries have to face will be outlined.

In this discussion on the potential for further expansion and development of wood processing industries in developing countries it should always be borne in mind that the relevant conditions in the developing countries differ very widely, both regionally and between individual countries. A certain degree of generalization cannot be avoided but it must be remembered that what might apply to one region may not be fully applicable to other areas.

23/ Fibreboards are also discussed here in connexion with the other wood based panel. Boards of gypsum (sheet rock) or other mineral material are excluderd from the FAO statistics.

Particularly it should be borne in mind that there exist examples of high technology wood processing mills, matching those in the industrialized countries, in some of the newly industrialized developing countries.

This presentation is condensed; a more detailed treatment can be found in reference literature and background papers of the study which are included in the List of References.

3.2.2 Poles, piling, posts, pitprops and sleepers[24]

The demand for wooden poles and sleepers is either constant or, more often, decreasing in the developed countries due to the increased substitution by concrete, steel, and through the use of underground cables. In many of the developing countries, the demand is still increasing due to infrastructural development such as building of roads, railways, bridges, telegraph and power lines, although steel and concrete are increasingly used as materials for sleepers.

For poles and sleepers, either naturally durable wood species or species which can be impregnated have to be selected. But naturally durable species have in many areas become scarce or are too expensive to be used as rough wood. In addition, many of the hardwood species are too difficult or costly to impregnate or the durability of wood impregnated by known preservatives and treatment methods is not adequate for the purpose. Thus, the domestic production of sleepers, poles and piles in the developing countries is hampered by a lack of preservation plants, preservatives and knowledge of preservation technology.

Therefore, important needs for the developing countries are:

- to diffuse the knowledge on commercially less accepted species (strength, natural durability, impregnability);

24/ Included in one grouping according to the ISIC. In the FAO statistics, sleepers are included in sawnwood data, when not tabulated separately.

- to obtain knowledge on wood preservation technology;
- to establish wood preservation plants and local production of wood preservatives, when feasible.

3.2.3 Sawmilling

Sawmilling was originally a labour intensive industry with relatively low capital and energy requirements. Since then, the trend in the developed countries has been to substitute capital for labour. With mechanization and automation, the labour requirement per output unit has decreased substantially. This trend can be expected to be accelerated also in developing countries due to increasing wages and the disappearance of simple equipment with a resulting adverse effect in their present comparative advantage where low labour cost is a factor. Table 3.3 shows production data for coniferous and non-coniferous sawnwood by region for the years 1970 and 1980.

Today the technology level of the industry varies from small low technology units to completely automated large mills. Correspondingly, the labour requirement may vary from less than 5 to more than 50 hours per cubic meter of output.

The quality of sawnwood depends essentially on the raw material properties (strength, durability, appearance, defect frequency, etc.) and on the manufacturing technology (dimensional accuracy, surface quality, grading, defect elimination, etc.). Over 50% of sawnwood is used directly in building and construction. Higher quality products are suitable for secondary processing (better quality furniture, joinery and engineered timber structures).

Sawnwood is a bulk commodity and the market is sensitive to overall economic trends and especially to the level of building activities. The cost of raw material is a large proportion of total production costs. In real terms, the price of sawn wood although fluctuating with general business

Table 3.3 Sawnwood (coniferous and non-coniferous) production
(1,000 m^3)

Region	Coniferous sawnwood 1970	Coniferous sawnwood 1980	Non-coniferous sawnwood 1970	Non-coniferous sawnwood 1980
Developed market economies	174,558	189,851	42,648	40,399
North America	90,379	100,326	18,172	18,650
Western Europe	47,754	54,880	11,973	12,437
Oceania	2,540	3,101	2,531	2,069
Other	33,885	31,544	9,972	7,243
Developing market economies	11,397	18,182	25,110	44,421
Africa	383	537	2,645	5,408
Latin America	7,420	11,443	8,067	13,832
Near East	2,186	2,982	672	1,126
Far East	1,368	3,148	13,578	23,793
Other	40	72	148	263
Centrally planned economies	126,144	115,492	26,514	26,502
Asian CPE	9,664	14,016	6,143	8,396
Eastern Europe and the USSR	116,480	101,476	20,371	18,106
World	312,099	323,525	94,271	111,322

Source: FAO *Yearbook of Forest Products, 1981*, *op. cit*.

conditions, has remained stable in the long run. Sawmills have responded to the increasing costs of raw material, labour and energy by increasing the production efficiency through improved recovery and production speed and savings in energy and labour. The technological developments, for temperate zone softwood, include integrated multi-band saws and chippers, and thinner cutting blades. Other new technology includes sensors to aid in sorting, location and optimal positioning of feed stock and programmable controllers and micro-computers. An important improvement in the field of managerial technology is computer-assisted optimization of production steering and scheduling. However, mills with such facilities are still the exception and not the rule.

These advanced technologies, although currently concentrated in the industrialized countries, will eventually, through their impact on the relative competitive positions, influence the development of wood processing industries in developing countries. They may not be adequate or suitable for most developing countries but it is a necessity that the development is monitored and followed by the developing countries in order to avoid future dependencies and structural crises.

Many sawmills are looking into the possibilities to add value by further processing of the products (drying, grading and in some cases stress grading, planing, preservation, etc.) These techniques are applicable to tropical woods but need further development, and the results disseminated to industries in the developing countries.

Sawmilling produces large amount of residues, (shorts, edgings, offcuts, slabs, chips, sawdust, bark), about 40-50% of the roundwood material. Today, the economic utilization of the residues is a necessity and their value actually rises with the increasing prices for raw material and energy. In developed countries residues are mainly used as raw material in the woodworking, particle board, fibreboard and pulp and paper industries and utilized for the production of energy consumed in wood processing. In most developing countries, residues are also used for fuel by the household sector.

In the developing countries, labour intensive technology is often the most appropriate choice especially for smaller mills producing products for the local[25/] markets. Simple sawmilling equipment is already produced locally but higher-technology equipment is imported which may give rise to problems of maintenance and spare parts later. Mechanization should be introduced in mills with large capacity. Unless very large machine outputs are required, manual and electro-mechanically operated log carriages and thickness adjustments should be preferred to pneumatic or hydraulically operated equipment. Further developments into automation and/or computerization can be decided on only in direct reference to the cost of the manpower needed. Automation and computerization require highly skilled maintenance crews and good communication and infrastructure. Quick expert assistance and availability of spare parts have to be secured.

In the developing countries, the majority of plants operate at very low efficiencies and the quality of products is low. The recovery rates are often only 30-40% in comparison to 50-70% in the developed countries, although the quality of logs is usually better and markets for the secondary material exist in the latter group.

Important improvements needed are:

- Technical assistance for the selection of appropriate machinery.
- Improvements in the air seasoning and kiln drying of timber in order to improve the quality of products and diminish losses.
- Use of appropriate sawing patterns.
- Better maintenance of the machinery and the cutting tools.
- Increased training both at the managerial and the technical level.
- Development of sawing and planning technology for commercially less accepted species.

[25/] In certain countries, the local or domestic market is so small or the regional market so homogeneous that it is more appropriate to refer to a regional market. Thus, the use of "local" and "domestic" in this study implies a regional market as well when appropriate in the context.

- Use of appropriate grading technology for tropical sawn timber.
- Adaptation of equipment for small diameter log processing to convert logs from plantation forests.

3.2.4. Wood based panel industries

Panel products are comprised of a variety of raw materials from complete sheets of veneer, through relatively large wafers, smaller flakes, wood particles - shavings, saw dust, - strands of fibrous timber material down to individual wood fibres. Vegetable fibres and certain ligno-cellulosic agricultural wastes can also be used. Moreover, fibreglass, rock fibre, carbon fibres and synthetic organic fibres may also be incorporated. The particles and resins may be combined in various ways.[26/] The world production, by region, of the more important forms of wood based panels is shown in Table 3.4.

Plywood is the most established and conventional of the wood based panel products. It includes a variety of products incorporating a veneer cross banded construction. It may be all veneer, or a combination of veneer outer plies with a core of solid wood, particle board or some other core material. Plywood is produced from coniferous or non-coniferous species and from a mixture of the two. In general softwood plywood is used for structural purposes and hardwood plywood for decorative purposes, although there are many exceptions to this rule. The bulk of plywood is manufactured to standard sizes, thicknesses and constructions and sold as stock commodity items, while some plywood is custom-built to size, thickness and construction to meet the needs of the consumer.

[26/] For a review of the technology in panel products industries and the raw material availabilities, see background paper "Mechanical wood processing industries in developing countries" by G. Heilborn and J. Swiderski, UNIDO, ID/WG.395/5. For an analysis of consumption and international trade see FAO Wood Resources and Their Use as Raw Material, op. cit., Chapters 2 and 4 particularly.

Table 3.4. Panel products production

(1,000 m^3)

Region	Plywood		Particle board		Fibreboard	
	1970	1980	1970	1980	1970	1980
Developed market economies	26,293	29,650	14,689	29,342	11,027	10,038
North America	15,929	18,338	3,460	7,367	6,755	6,343
Western Europe	3,139	2,699	10,431	20,023	3,152	2,800
Oceania	160	129	318	743	268	246
Other	7,066	8,484	480	1,209	852	649
Developing market economies	3,238	6,136	638	2,253	587	1,283
Africa	248	413	48	140	4	12
Latin America	725	1,497	383	1,407	418	1,022
Near East	98	109	163	606	55	92
Far East	2,151	4,100	44	100	110	156
Other	16	17	...	...	...	...
Centrally planned economies	3,643	4,488	3,843	8,735	2,594	5,194
Asian CPE	807	1,584	30	44	188	461
Eastern Europe and U.S.S.R.	2,836	2,904	3,813	8,691	2,405	4,733
World	33,174	40,275	19,170	40,330	14,207	16,514

Source: FAO, 1980 Yearbook of Forest Products, op. cit.

Plywood production requires only a moderate level of technology, energy and labour skills and has established world-wide markets in furniture, packaging and internal and external sheathing. Material quality, particularly sheathing, in the faces, must be high for many purposes, and high quality veneers may be used for furnishing and finishing uses. The external grades are bonded with water-proof resins.

In many developing countries, the plywood industry is considered the most important of the mechanical wood processing activities in terms of developmental strategy.

The production of various types of blockboard often complements the production of plywood, and it requires relatively low investment. Production of these boards increases the utilization of plywood cores and the product has a ready market in the furniture and joinery industry. Altough blockboard is more expensive than particleboard it does not require special hardware and fittings.

Particle board includes a variety of wood based panel products made of small fragements of wood bonded together with an adhesive. Among the mechanically processed wood products, particle board is of the most recent origin, having appeared on the world scene since World War II. The 1970s showed a high rate of expansion of this industry with the Europeans dominating and substantial production also in North America and the USSR.

Particle board is a direct competitor of plywood in many uses and is often sought as substitute on the basis of its lower cost. It is likely to be in greater demand as a plywood substitute, as veneer logs become increasingly scarce and more expensive. It is also likely to find great demand as a core material for veneer faced panels. The latest development is structural particle board (oriented strand board). This is a competitor of structural softwood plywood and is likely to experience a rapidly growing consumer acceptance.

Particle board industries are relatively indiscriminate with respect to the quality of the wood raw material and this cost is consequently low, whereas the cost of synthetic resin is relatively high. The capital requirements, energy requirements as well as the requirements for manpower are at medium level.

Fibreboard, using the wood fibre or small bundles of fibres should also be mentioned since it is a panel product. It is made from fibres of wood or other ligno-cellulosic materials with the primary bond deriving from the felting of fibres and their inherent adhesive properties. This product has gained considerable markets due to its price competitiveness compared to other panel products. A rather new product is the medium density fibreboard (MDF). Presently, it is being produced mainly in North America, and continental Europe. The basic process to produce MDF is similar to that used to produce particle board with the exception of the process of obtaining the fibre. Chips, shavings, sawdust and many other (residual) materials as well as synthetic resin are utilized. Almost any rough low quality waste wood can be used. The panels are pressed to any desired thickness and cut to any size requested. MDF is used in the manufacturing of furniture and shop fittings.

Tables 3.5 to 3.8 represent an attempt to summarize the requirements of raw materials, technology, manpower and capital requirements as well as market requirements of the various forms of panel products. The main conclusions that can be drawn from these synoptic tables are that most of these products are suited for production in developing countries and that the constraints are more related to the development of skilled manpower, infrastructure, etc. rather than to technological and financial requirements.

Table 3.5. Synopsis of raw materials considerations (from the point of view of developing countries)

ASPECT	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
A. AVAILABILITY				
1. Form of ligno-cellulosic material	only logs	logs, offcuts and chips	logs, offcuts and chips	logs, offcuts and chips
2. Range of species	most species	only a limited density range can be used	the density range is even more limited than for fibreboard	all are acceptable
3. Chemicals needed	UF or PF ± 4 %	Wet process : nil Dry process : 3% PF	UF : ± 9%	UF : 8-10% Cement : 50% for low density 300% for high density board
B. COST				
1. Cost at source :				
- wood	very high	low	low	low
- agricultural residue	n.a.	depends on local conditions	depends on local conditions	depends on local conditions
2. Transport and Handling				
- wood	high	low	low	low
- agricultural residue	n.a.	depends on local conditions	depends on local conditions	depends on local conditions
3. Chemicals :				
- UF and PF	high (in most developing countries) irrespective of type of panel made			
- cement	n.a.	n.a.	n.a.	low
C. NEED FOR R+D				
- wood	none	none	none	none for UF bonded boards (?) for cement bonded boards
- agricultural residue	n.a.	most need further R+D	most need further R+D	most need further R+D

Source: Guidelines for the Selection of Options in Establishing Wood-based Panel Industries in Developing Countries, ID/WG.335/16, UNIDO, Vienna, November 1981.

Table 3.6. Synopsis of technological considerations (from the point of view of developing countries)

ASPECT	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
A. WOOD RAW MATERIAL YIELD	40 - 50%	75%	90%	Resin bonded and high density cement bonded : 90% Low density cement bonded 50 - 70%
B. TECHNOLOGICAL LEVEL				
1. Suitability for developing countries	simple, most suitable	wet process, batch : simple suitable. Wet process ; conventional : suitable for many countries. Dry process : suitable only for more advanced developing countries.	Suitable only for more advanced developing countries	synthetic resin bonded board : and high density cement bonded board : suitable for most developing countries. Low density cement bonded boards : suitable for all countries.
2. Maintainability of equipment	simple	wet process : medium dry process : sophisticated	sophisticated	synthetic resin bonded board and high density cement bonded board : medium. Low density cement board : very simple.
3. Industrial infrastructure required	simple	medium	medium	medium except for low density cement bonded board : very simple.
4. R+D needed	limited	wood raw material : medium; agricultural residues: high	wood raw material : medium agricultural residse : high	wood raw material : medium agricultural residue : high
5. Operation of process	one shift operation possible	process must be continuous (except the Deckle box process)	process must be costinuous	synthetic resin bonded and high density cement bonded boards : one shift operation difficult; Low density cement bonded board: one shift operation easy.
C. MINIMUM ECONOMIC CAPACITY (FINISHED PRODUCTS)				
- local market	7.000 m^3/year	15-20 tons/day	50-75 tons/day	synthetic bonded and high density bonded boards : - 20 - 30 m^3/day - 150 cu.m./day Low density cement bonded boards - very low - n.a.
- export market	42.000 m^3/year	75 tons/day	150 tons/day	
D. ENERGY REQUIREMENTS				
1. Electric power	low	high	higher	synthetic resin bonded boards + high density cement bonded boards medium low density cement bonded boards : very low
2. Fuel (heating)	nil (if burns waste)	wet process : higher dry process : high	high	synthetic resin bonded boards + high density cement bonded boards : medium. Low density cement bonded boards : nil.
3. Water	very small	wet process : very high dry process : small	small	synthetic resin bonded boards : small. Cement bonded boards : medium.
E. ECOLOGICAL CONSIDERATIONS	small problems	wet process : very serious problems. dry process : medium problems	medium problems	synthetic resin bonded boards : medium cement bonded boards : low

Source: Guidelines for the Selectionof Options in Establishing Wood-based Panel Industries in Developing Countries, ID/WG.335/16, UNIDO, Vienna, November 1981.

Table 3.7. Synopsis of manpower and capital requirements considerations (from the point of view of developing countries)

ASPECTS	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
A. MANPOWER REQUIREMENTS:				
1. Local Availability				
- skilled workers	could be trained on the job	could be trained on the job (except for electricians + mechanics)	could be trained on the job (except for electricians and mechanics)	could be trained on the job (except for electricians and mechanics)
- unskilled workers	no problem	no problem	no problem	no problem
- expatriates requirements	normally not needed	wet process: few needed dry process: some needed	some needed	synthetic resin bonded board and high density cement bonded board: few needed. Low density cement bonded board : none needed
2. Training Requirements				
- on the job	needed	needed	needed	needed
- abroad	normally not needed	not needed	not needed	not needed
B. CAPITAL REQUIREMENTS:				
- total value	relatively low	"medium"	"medium"	synthetic resin bonded boards: "low to medium". High density cement bonded board: "medium to high". Low density cement bonded board : very low.
- local currency	± 50%	± 30%	± 30%	Synthetic bonded board and high density cement bonded board : ± 30% ± 70%.
- foreign currency	± 50%	± 70%	± 70%	Low density cement bonded board ± 20% ± 80%

Source: Guidelines for the Selection of Options in Establishing Wood-based Panel Industries in Developing Countries, ID/WG.335/16, UNIDO, Vienna, November 1981.

Table 3.8. Synopsis of market considerations (from the point of view of developing countries)

ASPECT	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
A. SIZE OF MARKET :				
1. Local Market - present - potential	very good good	good good	limited very good	good very good
2. Export Market : - present - potential	very good very good/ excellent	limited very low	low (?) limited	very low very low
B. PROMOTION REQUIREMENTS :				
- local market	none needed	none needed	needs serious promotion	needs serious promotion (for all types of panels)
- export market	none needed	none needed	needs serious promotion	none needed
C. RANGE OF APPLICATION :				
1. Panels "as produced"	very good	limited	medium	good
2. Improved panels	even better than C1	better than C1, but still limited	good	very good
3. Versatility	most versatile type of panel (interior and exterior use)	least versatile (only interior use)	better than fibreboard, but not as versatile as particle board (interior use only)	UF bonded board : varied applications (only interior use). Cement bonded board : only construction (interior + exterior use)
D. PRICE RANGE 1/				
- timber surplus countries	5	2	4	UF bonded boards : 3 Cement bonded boards : Low density : 1 High density : 4
- timber deficient countries	n.a. 2/	3	5	UF bonded boards : 4 Cement bonded boards : n.a. 2/

1/ Rated from 1 (lowest) to 5 (highest)

2/ Unlikely to be produced locally

Source: Guidelines for the Section of Options in Establishing Wood-based Panel Industries in Developing Countries, ID/WG. 335/16 Vienna, November 1981.

3.2.5. Secondary processing

The concept

Secondary processing industries are those which use the primary products (sawnwood, panel products) for further manufacturing and/or assembly of products for various end uses.[27/] The separation between primary and secondary processing is not always discrete and the classification of secondary wood products varies in different data sources. The segregation of data is specially difficult when the product group can include various wood and non-wood materials (e.g. furniture).

The main groups of secondary wood processing products are:

Structural
- formwork, falsework, scaffolding, earthworks
- roof trusses, portal frames
- beams, walls, engineered products

Non-structural
- furniture including built-in cabinetry
- doors, windows, shop fittings, floorings, trim, partitions, mouldings

Other
- crates, boxes, cases, containers
- pallets
- boats, vehicles and vehicle parts
- sporting goods, toys, pencils
- matches
- wooden ware.

[27/] For a full discussion of these industries see background paper to this consultation by H.P. Brion: "Current status and future development of the secondary wood processing industry of developing countries," UNIDO, ID/WG.395/4, 1983.

In general, the construction related products dominate the use of sawnwood whereas the panel products also go to joinery work and the furniture industry. Of sawnwood, as much as two-thirds can end up directly or indirectly in the construction sector. Approximately one-third of the panel products (mostly particle board) are used in the making of furniture.

The level of technology extends from manual work with hand tools in small workshops to large-scale industries using automated machinery for streamlined production. Small-scale enterprises using modern technology and mechanical equipment are dominating in terms of value of output.

Secondary processing usually needs less investment capital per unit value of production or employment created than primary industries. The amount, however, varies a great deal with the scale of the operations, the larger mills require less capital per output unit but also employ fewer people per unit of output.

The development and expansion of the secondary processing sector is generally dependent upon the primary sector. It may be integrated with units of primary processing or be established within the same region, however, it may also be located at a distance from forest resources and even be based upon imported raw material.

The secondary products are principally domestic market products, but joinery, furniture and construction products may find acceptance in the world market, too. The international market is characterized by strong competition, protectionist tendencies and elevated requirements as to quality, standards, design and adaptation to end use. To be competitive, a high operation efficiency is needed in the production.

The selection of appropriate technology is influenced by the type and quantity of production costs and skills of locally available labour. Material handling equipment and auxiliary equipment, eg. for tool maintenance and dust exhaustion, must be considered in addition to the main machinery.

Taking into account the increasing demand for forest products on local markets, secondary wood processing industries are expected to expand in the future. The majority of the operating units in developing countries are at present workshops or small factories. The efficiency of the production is low and the quality of the products meets only the minimum quality required by the local market.

Furniture and joinery products

The export market requires high standards of design, high quality of raw materials, interchangable parts, good packaging and regular and on-time delivery. Modular designs are sometimes advantageous. Therefore, the possibilities for export are generally low in the developing countries, as the necessary quality, punctuality, and quantity cannot yet be managed. The purchasing power of the domestic market being low, the development of the industries is constrained but increasing with increasing incomes.

Yet, reasonable markets can be built based on high level standard products for the domestic market, and on an accumulation of appropriate production know-how. As quality and skills increase, penetration into the export markets can take place, taking advantage of comparative low costs. The focus ought to be first on semi-finished furniture components, then on simple utility furniture and standard wood products for specific markets for which a marketing channel is available.

Trends in design and tastes have brought in more and different tropical hardwoods but oak is still the dominant species in the furniture industry. In applications such as such as drawer sides and runners, various tropical hardwoods are used, often in replacement of other hardwoods, but for price reasons they are themselves being replaced gradually by plastic materials.

In Europe in general, the use of tropical hardwoods in furniture is high in countries where its use in construction is of lesser importance. Thus, furniture is the main sector using tropical hardwood in Eastern Europe. Although the quantities are relatively small, tropical hardwoods in furniture is also important in all the Nordic countries as well as in Italy, Portugal and Spain. In the United States, tropical hardwoods are much more important in structural uses.

Economies of scale in secondary processing

The secondary sector in developing as well as in developed countries consists mainly of small firms. This fact constitutes prima facie evidence that scale economies in the industry are not such as to make the small firm inefficient. For the developing countries, this implies that it is possible to start up factories on a small-scale and enlarge operations as markets, capital, and skilled labour become available.

To observe that the industry is not characterized by pronounced economies of scale does not imply that there are no advantages to the operation of larger plants. But these advantages are not great enough to shut the small producer out of the market.

Activities aimed at increasing the productivity of small firms have the greatest potential for increasing the overall productivity levels in this industry. These activities should be aimed at improving the technology, and managerial and marketing skills. The greatest improvements are to be gained by increasing the use of specialists in various aspects of design, production and marketing. Generally, the use of highly skilled specialists is confined to the larger plants because only these operations have large enough volume to justify employing them. If small producers are going to be able to draw on the services of specialists, it will have to be through one specialist serving several small firms. This can be accomplished through a variety of different arrangements:

a. Trade manufacturers' associations: It is particularly important that these associations involve both the larger firms and smaller firms. This entails the further development and encouragement of subcontracting as a way of doing business. While the exchange of technical and marketing information tends to benefit the smaller firms, the larger firms benefit from the increased political base that the organization can draw on in seeking solutions to problems common to the industry as a whole. Cooperation within the industry might involve identification of suitable designs, common marketing facilities, subcontracting schemes, common service facilities, and the gradual establishment of industry-wide quality assurance schemes. Trade associations can, and often do, play an important role in training of both workers and management.

b. Specialized services: For economies of scale reasons, it can be advantageous to establish common facilities for the provision of preservation and wood drying facilities, and of other specialized equipment such as veneering and edge banding lines for particle board, etc. -on a subcontracting or co-operative basis- for the use of firms too small to make full use of such equipment on their own.

c. Service and repair facilities: There is an urgent need to establish common facilities for the repair and servicing of tools and machinery to serve a number of small firms . These facilities might also logically be associated with the marketing of manufacturing supplies such as adhesives and surface finishes, sawnwood, panels and other raw materials, auxiliary materials, etc., thus making more efficient use of inventories and reducing the portion of the total capital of the industry that has to be used for working capital. These facilities could be operated as cooperatives or as independent firms.

d. Technical assistance: While larger firms are able to make full use of engineers and mechanics and other specialists to implement the results of research and development carried out in national industrial research centers, this is not true for small firms. Publications concerning the techniques of, for example, low cost automation, are not sufficient in most instances to enable small firms to actually implement these types of improvements. What is needed is manuals in local languages and the allocation of specialized talent to a number of small firms. The equivalent of the type of technical assistance provided in many countries to the agricultural sector would be appropriate. One method for implementing this type of assistance would be for it to be combined with the common service and supply facilities discussed above.

The provision of technical assistance through the local service and supply center might provide the sort of indirect subsidy appropriate for increasing the number and effectiveness of these types of facilities. This could also prove a more acceptable method from the perspective of the small producer who sometimes is suspicious of government interference in his business operations.

3.3 Processing techniques

The development of wood processing designs concentrated at the outset on softwood species of the temperate zone in order to match the needs of the industry in developed countries. The technology and the equipment appropriate for the processing of tropical hardwoods has to a large extent been developed for the processing of imported wood in industrialized countries. In research and development in the sector, the technology for local processing of tropical hardwoods in developing countries has been of secondary importance. For this reason it has sometimes been perceived that tropical hardwoods are not as well suited for processing as temperate woods. However, the real constraint is that optimal technology for processing tropical hardwoods under the special conditions of developing countries has been ignored by both buyers and sellers of machinery.

Presently, the variety of tropical hardwoods causes problems in their processing if they were to be used more extensively. If the characteristics of the wood species were fully known and techniques adapted, these problems could be converted into an advantage in producing specific products for specific end uses. For example, the interlocked, fine to moderately coarse textured grain of the previously less known Philippine species Toog (Combretodendron quadrialatum) has been capitalized upon in producing

"Philippine Rosewood", a Toog-faced plywood which is beautifully grained and exquisite in design.[28/]

In the wood processing industry in developed countries, the development of simpler designs as well as the product development has been rapid during the last few decades. The technological changes have aimed at reducing the production costs and improving the quality of products. Due to increasing prices of raw material, and energy and labour, increases in yield, savings in energy and reductions in labour requirements have been sought. Additionally, the more efficient use of wastes and by-products has improved the economic efficiency of production. Mechanization and automation have substantially reduced the labour requirements per unit of output.

In the industrialized countries, improved equipment and computer technology have helped to improve both the yield and the quality of products. An important development for the larger production units has been in management, including computer-assisted design of trusses and rafters as well as programming of the production and its control.

A typical world-wide feature of the wood processing sector is that it offers a wide range of scales of plants and technologies to be chosen according to the particular conditions. Due to accelerated technical development, the developing countries need in increasing amounts technical assistance from the international organizations for the evaluation and choice of appropriate technology. The level of technology used must be appropriate not only to the type and scale of production but also to the local resource endowments, infrastructure, capital, labour and management skills, and maintenance possibilities.

[28/] F.N. Tamolang et. al "Prospects of Plantation and Lesser-known Tropical Hardwood Species for Commercial Utilization", in Tropical Hardwood Utilization, op. cit., pp. 116-123.

In the developing countries, lower level, labour intensive technology is often desirable for small mills producing products mainly for local markets. Higher technology and mechanization is needed for large mills aiming at the international market. Higher technology calls for more skilled technicians, supervisors, maintenance and management personnel. Few factories in the developing countries are yet in a position to apply full mechanization in the processing of wood. Application of low cost automation, however, offers possibilities specially in secondary processing, providing that the necessary basic technical knowledge is available. On the other hand, because of generally low wages and lack of adequate capital in the developing countries, there is no great urge to substitute capital for labour (see section 3.1 above).

The majority of plants in the developing countries operate at very low efficiencies and the quality of products is lower than in most industrialized countries. Technological improvements aiming at increasing the recovery and quality together with improved utilization of waste materials, will be necessary for competitive production. It has to be reminded, however, that profitability, productivity, recovery, and quality often can be improved more easily and at lower cost by better management, training, skills and maintenance than by better machines.

The technological improvements and development needed in the wood processing industries in the developing countries include, among others:

- Designs better suited for industrial production, and whenever possible, on a knock-down basis to reduce transportation and assembly costs.

- Better material handling technology. In many cases the quality of raw material and semi-finished products deteriorates during the various storage, transport and handling phases, leading to material losses and poor quality of finished products.

- Better control of drying in order to reduce losses and improve quality. Increased utilization of drying kilns for sawn timber is necessary for shipments to regions with drier climates.

- Improvements in the quality and maintenance of wood working equipment and increased use of jigs to improve dimensional accuracy, surface quality etc.

- Adoption and use of grading rules in primary processing to facilitate separation of products according to their quality, and end-uses.
- Improvements in gluing and finishing technology for various wood species and products.
- Better jointing techniques for structures.
- Improvements in packaging technology for finished products.
- Improved wood preservation.
- Better industrial engineering in the mills.
- Developing and adoption of quality assurance systems.

An identified obstacle to the use of commercially less accepted species is ignorance of the quantities of raw materials that are available. Another obstacle is the economical consequences of changing technologies. Thus it is necessary to

- establish parameters for the grouping of such species having sufficiently similar properties,[29]
- establish minimum supplies of such species, or of groups of species having sufficiently similar properties,
- conduct inventories (to ascertain that minimum supplies are available within economic distances), and
- develop the techniques for mixed species processing.

When the raw material endowments of a developing country are very rich, or when both capital and high level skills are available (as in Singapore, for example), it would be advantageous to explore the economic and financial feasibility of even the highest technology. However, special emphasis must be paid to both short and long term financial constraints, markets, and the continued availability of skilled labour.

Within each product group, and within each scale of production, there exists a wide range of technologies available. The choice among them depends on:

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[29] For a detailed discussion, see O.P. Hansom, Promotion of Commercially Less Accepted Species, UNIDO, ID/WG.395/1, 1983.

- size of potential markets,
- raw material, quantity and quality,
- availability of skilled labour and training facilities,
- availability of capital,
- energy and other auxiliary input requirements,
- availability of industrial and institutional infrastructure, including ease of obtaining spare parts,
- environmental considerations,
- existing plants or machinery that need to be fitted into any new or expanded production facilities.

3.4 Wood in construction

The construction sector has been the most dynamic end-use sector for tropical hardwood over the past 10 to 15 years in a number of major importing countries. Of course the general economic recessions have always affected the construction industry and thereby the use of wood.

The most important utilization of the various forest products in construction is in new dwellings. Table 3.9 shows the estimated shares for Europe.

From the point of view of wood utilization, it is important to distinguish between single and two family houses as opposed to multiple unit buildings. The former are, as a group, constructed with a considerably larger share of wood based materials than the latter category. For Europe as a whole, completions of single and two family dwellings accounted for approximately 38 per cent of total dwelling construction in 1975. This share tends to remain fairly stable over the long run although fluctuations occur from year to year and from country to country. The EEC countries have shown an increasing trend towards one and two dwelling houses.30/

30/ ECE Annual Bulletin of Housing and Building Statistics for Europe.

Table 3.9 Estimated use of forest products in European construction, 1970

	million m^3 in total construction	in new dwellings	Use in new dwellings as percentage of use in total construction (%)
Soft sawnwood	48.8	18.5	37.9
Hard sawnwood	5.4	2.4	44.4
Total sawnwood	54.2	20.9	38.6
Plywood	2.4	1.1	45.8
Particle board	5.4	2.2	40.7
Fibreboard	2.7	1.0	37.0
All wood based panels	10.5	4.3	41.0

Source: European Timber Trends Study, Third Updating (ETTS III): supplement 3 to Vol. XXIX of the Timber Bulletin for Europe, Geneva 1978.

For the average European, hypothetically calculated dwelling, structural and temporary construction site uses accounts for 55 to 60 per cent of sawnwood consumption (or 3.3 to 3.6 m^3), and joinery uses make up the remaining 40 to 45 per cent (or 2.4 to 2.7 m^3).[31/] For tropical hardwood, joinery uses are of importance although efforts are being made to increase the structural uses of such wood. Among the primary joinery uses are windows, doors and frames, trim, built-in cabinetry, partitions and panelling, flooring, and stairs.

On the average, there are approximately 2 to 2.5 times more doors than rooms (excluding kitchens and bath rooms). Thus, there are generally 6 to 8 doors in a medium sized apartment and 10 to 14 doors in a single family house. Generally, there are fewer windows than doors but their number and

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31/ Supplement 6 to Vol XXIV of the Timber Bulletin for Europe, Geneva, 1973.

size can vary considerably with the architectural design. The approximate sawnwood content of interior doors varies from 0.015 to 0.030 m^3 per door, and is approximately 0.14 m^3 in non-flush exterior doors. Windows of 1.5 m^2 area use between 0.05 to 0.15 m^3 of sawnwood depending upon the frame construction and the use of non-wood materials.

Flush doors represent a relatively standardized product that is industrially manufactured in long series. Both softwoods and hardwoods, including tropical hardwoods, are used. Decorative, hand carved doors from developing countries have found a receptive market in many European countries as well as in North America. Doors are often subject to rigid and sometimes outdated building and fire codes hampering the introduction of new products.

Wooden panelling has gained favour with home owners in recent years as has wooden flooring. But this extends to softwoods (for panelling only) and temperate zone hardwoods as well as to tropical hardwoods.

Built-in cabinetry is essentially a consumer good and thus subject to more frequent and unexpected swings in demand than the other uses of wood in construction. The same basic piece of furniture comes in a variety of shapes, sizes and finish in order to satisfy consumer preferences. This complexity of the product and its markets is reflected in the structure of the furniture industry. Although concentration and rationalization of the production process has ocurred, artisanal production still accounts for 15 to 35% of furniture production in terms of value[32/]. Developments in design and manufacturing techniques as well as increasing prices for wood has increased the use of wood based panels, especially of particle board, at the expense of sawn wood.

[32/] Study of the Trade and Utilization of Tropical Hardwoods, Timber Section of the ECE and FAO Agriculture and Timber Division, Supplement 10 to Vol. XXX of the Timber Bulletin for Europe, Geneva, 1978.

The development of low-cost housing for domestic markets is important in many developing countries. Various components, sills, flooring, wall units, wall claddings etc. can be manufactured at a sawmill where a moulder is available. However, building components standards should be established at an early stage of industrial production. Outdated building code requirements ought to be revised to facilitate the use of wood in construction.

In developing countries, prejudice often exists against wooden houses. They may be used in forest regions and agricultural frontiers, but generally they are considered second class compared to brick and cement block houses. Thus, wood construction is often associated with the homes of the very poor and hence enjoys a low status.

The development of wood preservatives, quite possibly based upon local materials, is an important step in promoting the use of wood in construction in tropical climates. But much missionary work is needed - preferably in the form of full-scale demonstration projects - to educate regulatory agencies, financial institutions and the ordinary consumer about timber used structurally.

Wooden structures are particularly suitable in seismic regions, for temporary structures, and in low-rise housing and school buildings. Local materials and traditional designs have comparative advantages here.

3.5. Possibilities for integrated production

As has been shown elsewhere in the study, it is most important for developing countries to improve the yield of the commodity recovered from forests. This necessitates the development of a mix of industries, integrating primary and secondary processes for the purpose of having a wide range of products for marketing, the salvage of small components, recycling of wastes and the achievement of a certain degree of energy self-sufficiency.[33] Integration then will mean a better utilization of the raw material as well as a better stability in relation to a fluctuating market through the increased number of products.

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[33] For a supporting discussion in terms of "complex utilization" of the wood resource in developing countries see N.A. Burdin and V.A. Sylantyev, op. cit.

Integrating production does not require that all the indicated steps are taken at the same time. This would necessitate setting up fairly large-scale production units which may not be within the immediate possibilities of many developing countries. A stepwise integration on a relatively small-scale is, however, practically always possible and should be stimulated.

Sawmilling and plywood industries have relatively high raw material (logs) requirements compared to chemical processing although, in some cases, sawmilling also uses lower grade material. Therefore, the selection of raw material allows only a small share of the forest potential to be utilized. Furthermore, logging and processing residues at various stages usually account for more than half at the original roundwood raw material. For more efficient utilization of the forest potential, this residue should be put to use. The total amount of residues from the mechanical wood processing industries is estimated to amount to about 500 million m^3 (1980) or nearly 60% of the roundwood raw material (Table 3.10). Less than half, 47% (235 million m^3), is used as raw material for panel products and pulp industries, and 18% (90 million m^3) for energy. The remaining material, more than a third globally, (34%, 170 million m^3), has no industrial use. However, the share going to industrial use is high in the developed countries but very low in the developing countries, practically nil in Africa and Latin America (see Table 3.9). This indicates a large potential for higher integration of the production process, particularly in these regions. The potential uses for residues are:

- raw material for mills producing furniture components, parquet, pallets, crates and other similar products,
- raw material for particle boards, cement bonded particle board or fibreboard,
- raw material for the pulp and paper industry,
- fuel to produce energy in the same mill producing the residue,
- fuel for other uses, and
- chemical processing of timber.

The possibilities in developing countries to establish mills producing furniture components etc. or panel products industries based on sawmill or plywood production residues are dependent on the existence of markets for the products. In many countries where this type of processing, e.g. particle board industries, is scarce or lacking, the market has to be created. In most cases, the new mills should best be rather small and a low-technology solution may be the most appropriate initially. A cement-bonded wood-wool or wood chip board mill or a workshop producing boxes or pallets from pieces of sawn timber constitute examples. When larger markets are found and collection systems for adequate raw material have been developed, e.g. from a number of mills located in the same area, larger mills will be justified.

The quantity of residues is seldom large enough to justify a pulp mill, although, in some cases, residues are chipped and sold to pulp mills, either domestic or abroad. Another major constraint is that chemical pulping is very capital intensive.

Wood fuel is a well established use in the tropics. In fact, about 80 per cent of wood harvested is being used as a fuel. More efficient use of the residues from primary industries would need forms that have higher calorific value and are easy to transport, e.g. charcoal and methanol. The technology is available, costs and raw material quality requirements are relatively low and a substantial domestic market exists in essentially all the countries.

Integration of various product lines in order to achieve a better yield of the raw material should be a goal for the wood processing sector in developing countries. It can be approached in a step-by-step manner. Although experience of some large integrated projects in developing countries shows that they tend to run under capacity, be difficult to manage and not cost effective, the vertical integration of small individual processing units or plants is economically desirable in terms of increasing the utilization of the wood raw material, diversifying the product range, and furthering the division of labour. The technology for integration of small facilities exists. In developing countries, such integration should be a proper focus of national and regional development plans. More research is, however, required

3.10 Estimated volumes [a] of roundwood input, product output and residuals created and used domestically 1980, (million m^3, except col 9, per cent)

	Sawlog and veneer log input (1)	Sawnwood and Sleepers		Solid wood Panels		Total Residuals (6)	Residuals IMPORTED (EXPORTED) (7)	Residuals used domestically (8)	Per cent INPUT USED (9)
		Product volume (2)	Residuals created (3)	Product volume (4)	Residuals created (5)	(3 + 5)			[(2+4+8)÷1]*100
WORLD	904.8	428.8	373.2	48.4	54.4	427.6	–	190.0	74
North America	286.0	97.9	141.6	21.5	25.0	166.6	49.4	96.2	75
Western Europe	126.6	68.6	48.9	4.2	4.7	53.6	–	34.9	85
Japan	70.6	41.4	15.6	6.8	6.8	22.4	13.6	11.5	85
Middle East and North Africa	2.1	0.6	0.4	0.4	0.6	1.0	–	–	48
Oceania	15.2	6.0	8.6	0.3	0.3	8.9	–	3.5	65
Africa, South of the Sahara	12.5	6.2	4.1	1.1	1.1	5.2	–	–	56
Far East	49.9	20.9	15.0	6.6	7.4	22.4	–	3.6	62
Centrally Planned Economies:									
Eastern Europe	38.3	23.5	11.7	1.3	1.7	13.4	–	6.5	82
U.S.S.R.	233.1	124.7	99.7	3.7	5.1	104.8	–	10.5	60
Asia	39.9	21.6	17.2	0.6	0.5	17.7	–	5.7	70

Source: FAO, Forestry Paper No. 29, op.cit.

[a] These figures are in terms of cubic meters of "fibre volume", which is the amount of unbarked wood per reported measure of product volume.

to facilitate increased integration in small-scale production units, that is to adapt integration technology so that it can be more fully utilized in the developing countries.

3.6 Other aspects of wood processing industry in developing countries

3.6.1 Manpower requirements

Mechanical wood processing industries are relatively labour intensive industries and mills in developing countries tend to be more labour intensive than those in industrialized countries (cf. section 3.1 above). Obviously modern factories tend to be less labour intensive than older mills. Within the primary wood industries themselves there is great variation in labour requirements. Sawnwood manufacturing requires, as a rule, the most labour per m^3 of output. Plywood has less and particle board and fibreboard has the least manpower requirements per unit of output.

The labour requirement for the manufacture of veneer in West and Central Africa ranged from 23 to 60 manhours per m^3 and from 36 to 140 manhours in the production of plywood[34]. As a comparison it can be mentioned that in Europe the manpower requirements for plywood manufacturing ranges from 20-30 manhours m^3. There are also several other examples of the very high variation in manpower requirements within production units for the same kind of product.

Sawmills and plywood mills with high labour requirements per unit of output tend to use manual labour for material handling between operations. While many mills in developing countries have well trained and experienced machine operators and supervisors, it is nonetheless true that the availability of trained operators is a major bottleneck. Few of the developing countries are in a position to train skilled machine operators and supervisors. In spite of government policy in many countries to avoid using indigenous skilled and supervisory workers, expatriates are used in supervisory positions in many sawmills and plywood factories. Schemes to replace expatriates with nationals have often failed. Expatriates are often recruited from other developing countries where the industry is more developed.

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[34] Takeuchi, op. cit.

Skilled labour in the wood and wood processing industry in developing countries are mainly graduates from trade and vocational schools often trained more as craftsmen than as skilled machine operators and will need extensive in-plant training to upgrade their skills to the level necessary for secondary wood processing on an industrial basis. There are hardly any institutions in a developing country that train machine operators and other specialists in a sufficiently industry-oriented way. There is also a lack of training of designers and product engineers for the secondary wood processing industry as well as for management. This lack of training facilities constitutes one of the main bottlenecks for developing countries when trying to establish a wood processing industry.

In most developing countries with significant forest resources training for employment in the mechanical processing industries at the vocational or technical level should be done within the country. It is likely that with the expansion of the industry, the number of wood technicians required for managerial level posts will be large enough to justify the curriculum in a university.

3.6.2 Industrial, institutional and social infrastructure

By infrastructure is meant the basic facilities that are necessary to ensure the development of the wood processing industry. These include transport and communications, utilities such as energy and water, technical and political business services provided by manufacturers' associations, consulting firms, certifying agencies, and other services including health and housing as well as the socio-political environment. The level of infrastructure available, of course, varies depending on the state of development of the country concerned. Countries wishing to develop the processing sector must make substantial initial capital investments for the harvest and raw materials operations providing certain building blocks for the capital expansion into manufacturing. This would include: a basic knowledge of the forest resources; the transport facilities to reach and remove the logs; the labour force skilled in equipment operation and maintenance; access to markets for logs; and deepwater ports if exports are envisaged.

Transport and communications

The road transport network, comprising of primary and secondary roads that connect the logging operation to the processing plants as well as to the ports and market centres, is crucial to the development of a wood processing capability. Without proper access, supply is not forthcoming. This is one reason for the relatively poor development of forest-based industries in some developing countries despite the availability of resources. In some cases, it is not the availability of transport but the long distances to the domestic and export markets that are a hindrance. For example in Brazil, the Amazon area is blessed with the largest system of navigable rivers in the world, supported by a good network of roads. Nonetheless, transportation costs are high, at least for a relatively low value commodity such as rough sawn timber, and distances to the principal markets in the south and south-east of Brazil and to the overseas market are long and freights high.

Social infrastructure

Usually, adequate social infrastructure in terms of schools, housing and hospitals exists only in major population centres. Therefore, a forest-based industry established outside those areas will have to provide its own social infrastructure, which increases costs and affects the competitiveness of the industry. To counter this, many governments provide locational subsidies to promote development in remote areas.

Institutions

The role of manufacturers' associations, consulting firms, certifying agents, standards etc. can be essential in promoting the welfare of an industry. The costs and benefits of actions with industry-wide effects can be effectively disseminated through such institutions. In the developed countries, trade associations have often been instrumental in furthering the interests of their members. National associations are often members of a regional federation.

It can be seen from the above that the problem with infrastructure, as far as forestry is concerned, is either the non-availability of infrastructure due to a low stage of development, or the availability at a high cost thereby affecting the competitive position. The development of the wood processing industry requires that the cost of infrastructure be at least in part borne by the government. Where possible, wood processing plants would be fitted into an industrial area with other industries to share the burden of costs for providing facilities such as power, transport, housing, medical services, schools, etc. on an economical basis. Indeed this is being done in many countries where secondary wood processing industries are located in industrial estates, not necessarily near raw material supplies.

Shipping is dealt with in chapter 4.

3.6.3 Quality assurance

An important role of manufacturers' associations it to organize and maintain quality assurance including product and production standards inspection by independent and respected bodies. Provided that the quality labels or inspection certificates are believable, local standards promote the use of wood products not only at home but also on export markets.

Industry-wide quality assurance has proved to be a very useful device for promoting the sale of mechanically processed wood commodities in industrialized countries. Often conducted by a trade association, it is an industry-wide quality assurance procedure that gains the confidence of consumers, provides a solid basis for the arbitration of seller/buyer disputes, and is effective as a basis for both domestic and international trade promotion. As an example, the long established programme conducted by the American Plywood Association (A.P.A.) of the U.S.A. can be mentioned. The A.P.A. is the custodian of the plywood specifications upon which the programme is based.

There are several problems for developing countries in establishing an efficient quality assurance scheme. The inspection authority should have the leverage to enforce compliance with specifications and a right to grant or withdraw the use of grade marks, depending upon the quality performance of the member mills. A quality assurance programme should be performed by conducting spot checks of the grading performed at any factory and by regularly testing product samples to determine quality.

For some developing countries, where quality of products has been a major deterrent to effective marketing, a country-wide or industry-wide quality assurance programme might be an effective trade promotion and marketing tool. It is possible, however, that quality assurance programmes will be inadequate if undertaken within each country. Regional programmes, developed through wider co-operation agreements and using common inspection and testing facilities might be more effective in establishing a reputation of product quality.

Closely related to the question of quality control is the question of standardization. Obviously a product standardization with large coverage would bring great advantages and an important vehicle for creating new markets or penetrating competitive world markets. The Malayian Grading Rules can be mentioned as an example of successful standardization in developing countries. However, there is a problem with gaining wide acceptance for standards and rules.

3.6.4 Environmental aspects

The importance of the environmental aspects of the forest ecosystem and their impact upon the forest management strategies have been discussed in Chapter 1. Here we note that, in general, the development of infrastructure and the harvesting and transportation of wood has a greater potential environmental impact than the mechanical processing of wood itself.

The risks for environmental pollution associated with the mechanical wood processing industries and with the use of wood products in building industries are low in comparison to most industrial sectors. Moreover, the industrial pollution can usually be adequately controlled by proper planning and maintenance of the plants without costly investments. Therefore, environmental aspects have to be considered already in the planning phase of new industries.

Major potential sources of pollution within the sector are effluent disposal in wet-process fibreboard mills and wood preservation and surface finishing. This calls for special attention in the tropical countries, where the need for preservation is great, both in forestry and in processing industries, due to the high risk of biological wood deterioration. Environmental aspects and pollution control measures are throuroughly discussed in a supporting paper of the study[35/].

Some of the main points of consideration for the wood processing industries in the developing countries are:

- the effluent load from debarking plants, sawmills and plywood mills pose an environmental pollution risk, which can, to a significant extent, be reduced by appropriate design and careful operation;
- a fuller utilization of wood wastes will diminish the actual environmental and disposal problems;
- the development of material handling techniques should aim at minimizing the need for temporary preservation. When hydrocarbon insecticides and fungicides have to be used for the protection of logs during transport and storage, special care must be taken to eliminate the pollution of waterways;
- for long term wood preservation, preference should be given to closed cycle processes (e.g. pressure impregnation with water-borne preservatives);

[35/] prepared by K.M. Strzepek, "Environmental aspects of the wood and wood processing industry", UNIDO/IS.394, 1983.

- special care must be taken when disposing of the wastes from preservatives and treated timber. These are usually not suited for combustion and must be safely deposited in the ground;

- pollution from fibreboard production facilities can have serious environmental effects. Developing countries should make every effort to design environmental safeguards into pulping plants so that they do not repeat the mistakes of many developed countries, where pollution clean-up costs are high because extensive retrofitting of plants was required.

- efforts are needed to diminish the volatile organic compound (VOC) pollution from the finishing processes in the secondary processing industry. Settling ponds and basins with careful final disposal are recommended for the treatment of wood finishing wastes.

3.6.5 Occupational safety and health in the wood and wood processing industries[36]

This section is based primarily on information available from industrialized countries. As regards developing countries, publications and studies on problems related to occupational safety and health in the wood and wood processing industries are almost non-existant. However, the major safety and health problems in developing countries are discussed on the basis of general observations.

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[36] This section is based on "Health and safety problems in Wood and Wood Processing Industries", prepared by the ILO secretariat and issued separately (UNIDO/IS), forthcoming.

Guidance and recommendations concerning occupational safety and health activities is provided by: ILO Convention No. 119 and Recommendation No. 118 (Guarding of Machinery - 1963), Convention No. 139 and Recommendation No. 147 (Occupational Cancer - 1974), Convention No. 148 and Recommendation No. 156 (Working Environment - 1977), Convention No. 155 and Recommendation No. 164 (Safety and Health - 1981), ILO Model Code of Safety Regulations for Industrial Establishments (1949, Rev. 1954), Codes of Practice on Safety and Health in Forestry Work (1969), Safe Design and Use of Chain Saws (1978), Occupational Exposure to Airborne Substances Harmful to Health (1980), ILO reports on Occupational Safety and Health and Welfare in the Woodworking Industries (1967), and Occupational Safety and Health Problems in the Timber (Logging) Industries (1981).

Occupational safety and health risks in the wood and wood processing industries are similar in industrialized and developing countries. However, there are substantial differences arising from the use of different levels of technology, the extent and level of training, and the behavioural patterns and physical condition of workers.

Work accidents

In most industrialized countries the rates of accident frequency and accident severity in the wood and wood processing industries are considerably above the industrial average. This relationship has not changed much over the past 30 years. However, significant progress has been made in reducing the accident rates in all industrial sectors, including the wood sector. This has been mainly due to the use of improved machines, better techniques, stricter regulations and inspection as well as improved training and the more active involvement of employers and workers in safety matters. The disappearance of many small enterprises whose standards of safety and health tended to be lower than for larger firms and increasing automation and remote control of production processes also contributed to improved health and safety.

Continuous efforts need to be made in monitoring the introduction of new technologies (e.g. in power generation from wood waste) and the use of new materials (e.g. combinations of wood and plastic) so that adequate health and safety precautions and measures can immediately be taken - if and when any negative effects are noted. Woodworking machines (primarily circular saws, planers and spindle moulders), wood and wood products themselves (e.g. splinters from toxic species), as well as hand tools remain the principal agents of accidents.

Compared with saw milling, carpentry, joinery and furniture making, logging is by far the most dangerous. In spite of major improvements in the safety features of chain saws in most countries the accident frequency and severity in logging has not been reduced.

Occupational diseases

With respect to occupational diseases, there has been a steady increase in the number of workers affected as a result of exposure to a large variety of chemicals, dust and noise.

Substantial medical research has been concentrated, however, on the effects of exposure to chemicals and dust in the wood and wood processing industries. As a result of this research, less harmful chemicals are being substituted for more harmful ones, and other steps have been taken to make the production process less hazardous. In addition, measures have been taken to reduce workers' exposure to harmful substances (e.g. the use of spraying tunnels instead of manual spraying, and the use of more effective dust collection and ventilation equipment).

Modern machinery operates at higher feed rates and cutter speeds and hence generate more noise. As a consequence of the negative effects on workers' health of long-term exposure to high noise levels, more attention has been given to noise as an occupational hazard in the wood and wood processing industries. Considerable progress has been made in the reduction of noise by modifying cutting tools, providing machines and machine tools with enclosures lined with sound-dampening material, placing machine operators in noise-protected cabins and by the use of ear protectors.

In temperate countries, vibration of chain saws has become a serious occupational health problem leading to Raynaud's phenomena or vibration-induced white fingers. This problem has only been partly solved by improved machine design and, in some countries, by restricting the daily working time of chain saw operators or users.

Ergonomic conditions

During the past 15 years, there have been various studies that have concentrated on the ergonomic conditions of the wood and wood processing industries. These have revealed that even in the more mechanized larger enterprises in Scandinavia, a considerable proportion of workers were not only exposed to dangerous levels of noise, dust and chemicals but also to uncomfortable working postures, poor lighting and unfavourable climatic conditions. It would therefore appear that there is ample scope for major improvements in this respect.

In tree felling, physical stress is still of major concern except in cases where mobile harvesters are used. Workers in modern mills, though not experiencing great physical stress, face monotony and social isolation.

Developing countries

In the developing countries, the diverse types of operations in the wood and wood processing industries, ranging from traditional workshops to enterprises with one or a few simple machines to larger establishments with modern installations and hundreds of workers make it difficult to implement a comprehensive programme on occupational safety and health. Thus, industrial safety is generally lower in the developing than developed countries because working conditions, machinery and its maintenance are inferior, workers are less trained and less skilled, more work is done manually, medical inspections are rare, safety equipment is less available and less used, and safety legislation does not exist and/or is not strictly enforced. Traditional rural and urban production units are definitely in need of improved occupational safety and health performances. However, for a variety of reasons, they remain largely out of reach of any attempts to introduce safety and health conciousness.

Though only incomplete statistical evidence is available on accident rates in the developing countries, what is available confirms that accident frequency and severity is considerably higher (for comparable technologies) than in the industrialized countries. This is particularly the case in logging. Statistics on occupational diseases are unavailable or inadequate.

Occupational hazards caused by chemicals, dust (in workshops), noise and vibration are high but their effects may be less pronounced under conditions where long-term exposure occurs less frequently. As regards ergonomics, excessive physical demands in material handling is the principal problem.

The occupational safety situation is most serious in small mechanized workshops. Adequate protection can probably only be achieved if safety and health aspects are fully integrated into those activities aiming at increasing the operational efficiency of this sector of the wood industries. Emphasis must be given to basic requirements such as good housekeeping, minimizing physical stress and risks in wood handling and piling, guarding of transmissions and revolving machine parts and machine tools, notably circular saws.

More comprehensive activities are feasible in larger plants which maintain medical services for workers and which keep records of injuries. Under such conditions it is desirable to compile and analyse accident statistics, adequately apply and enforce safety regulations, provide safety training to all levels of the work force and ensure active participation of employers and workers in safety programmes. Up to now, this has been done only in exceptional cases, but wherever it has been done, the results have been rewarding.

In the wood and wood processing industries of developing countries, occupational safety and health requirements have been considered to some extent by various international agencies, countries and private companies within the context of technical co-operation and industrial development projects. However, on the whole, such endeavours have up to now only made a marginal impact and need to be continued in a more concentrated manner.

The main considerations for the developing countries are:

- old and less safe machinery should be, when possible, retro-fitted with safety equipments required by occupational health standards,
- in the selection of new machinery, safety aspects have to be adequately considered, even beyond prevailing safety prescriptions,
- industrial safety aspects must always be included both in managerial and technical training programmes,
- woodworking mills have to be provided with dust exhausting equipment (sawdust of some tropical hardwoods may cause nasal cancer, and skin and lung irritation),

- adequate fire prevention measures must be taken and fire precaution schemes introduced in the mills,
- various chemicals used in glues, finishes, solvents, and preservatives may cause allergy, eczema or cancer; safety instructions for the workers have to be prepared and workers have to be trained to follow them, and
- whenever possible, water-based finishes should be preferred to organic solvent based finishes.

3.6.6 Energy requirements

Wood products have an essential advantage over substitute materials in that relatively little energy is needed for mechanical processing. For normal energy requirements, see Table 3.11).

The energy requirement per unit output is lowest in sawmilling. There, the highest energy consumption goes to artificial drying. The energy requirement is higher for processing of hardwoods than softwoods. The most energy intensive product is fibreboard.

Specific energy consumption varies widely, the main parameters affecting it are: [37]

- length of drying cycle (usually imposed by wood species and initial moisture content; some species must be dried slowly to avoid deformation);
- thickness of sawnwood and size of pile;
- design of kiln (size, configuration, degree of insulation);
- outside temperature;
- efficiency and skill of operators.

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[37] ECE and Energy Conservation; Recent Experience and Prospects, Chapter E, Energy Use in the Forest Sector, United Nations, New York 1980, p.34

Table 3.11 Energy requirements per unit of final product in primary and secondary processing a/

Sector	Electrical kWh	Thermal Gf	Motor fuel litres
Primary processing (per cubic meter)			
Sawntimber, air seasoned			
- hardwood	30	-	5
- softwood	20	-	4
Sawntimber, kiln-dried			
- hardwood	75	2.5	5
- softwood	45	1.5	4
Plywood			
- hardwood	230	6.0	4
- softwood	150	4.0	3
Particle board b/			
- hard wood	160	3.0	3
- soft wood	120	2.0	3
Fibreboard			
- medium density			
low capacity, 60 tons/day	450	5.3	
high capacity, 180 tons/day	400	4.6	3-5
- hardboard			
low capacity, 60 tons/day	525	10.4	
high capacity, 180 tons/day	475	9.0	3-5
Veneer			
- hardwood	170	5.3	3
- softwood	110	3.3	2.5
Secondary processing (per ton)			
Furniture	350	4.0	3
Joinery	260	2.4	3
Packaging	120	-	2

Source: Wood and Wood Processing as a Consumer and Supplier of Energy, Chapter 3, UNIDO/IS , 1983, forthcoming; Fahrni Institute, Zurich; Sunds Defibrator (personal communication), Stockholm.

a/ These figures are for energy consumption in more or less typical well functioning plants. They are not meant to be absolute since plant design, raw materials used and other factors will cause significant variations in energy requirements between different plants.

b/ These figures apply to capacities 100-500 m^3/day.

A major advantage of the sector is that it can be essentially energy independent by using residues and wastes for the production of energy. Wood has a calorific value of 17-21 MJ per kg (dry weight), which can be utilized by burning in a boiler or a gas producer or by conversion into fuels with higher calorific value such as charcoal. For the production of electrical energy, a boiler that produces thermal energy must be combined with a turbine.

In thermal energy production, the efficiency is high (up to 75%) and the investment cost is relatively low. But the conversion of wood fuel to electrical energy gives an efficiency of only 33-37 per cent and the investment cost is higher than that for a thermal energy plant. An even and permanent take-off of electrical energy above the minimum of 100-150 kwh is a necessary precondition.[38/]

The calculations of the energy self-sufficiency potential show that the thermal energy requirements can in all cases be met from the available residues of mechanical wood processing. In addition, the electrical energy requirements can be fully met in sawmills and the larger secondary industries, though this does not consider economic limitations. In the most energy-intensive panel products industries, additional input of fuel would be needed. The sawmill industry can actually produce a surplus of heat and electricity and thus could support energy deficient conversion processes in an integrated complex or in rural areas supplying energy for the needs of the surrounding community.

The type of energy consumed by the wood based industries is shown in Table 3.12. Note that the distribution among different fuels is likely to be different today due to changed relative fuel prices and changing technologies.

[38/] Wood and Wood Processing Industry as a Consumer and Supplier of Energy, UNIDO/IS, 1983, forthcoming.

Table 3.12 Relative importance of different energy sources for the forest industries, 1972

(per cent)

	Pulp and paper sector			Mechanical wood processing sector		
	Fossil fuels	Purchased electricity a/	Wood based b/	Fossil fuel	Purchased electricity a/	Wood based b/
Austria	62	11	27	55	41	4
Canada	28	23	49	33	49	18
Finland	17	40	43	57	28	15
France	51	35	14	...	...	...
Germany, Fed.Rep. of	87	9	4	64	36	–
Hungary	12	80	8	58	42	–
Norway	39	52	9	45	54	1
Spain	55	26	19	47	48	5
Sweden	30	36	34	43	54	3
USA	60	12	28	71	29	–
Yugoslavia	63	26	11	56	44	–

Source: ECE and Energy Consumption, *op. cit.*, p. 36.

a/ i.e. the amount of heat energy needed to generate the electricity consumed by the industry assuming plant efficiency of 40 per cent. This method assures comparability between centrally-generated and internally-generated electricity.

b/ Wood residues, bark, pulping liquors (estimated).

In the developed countries, wood wastes are mainly used for raw material in the particle board, fibreboard and pulp industries. Bark and sawdust are already used to a relatively high extent for thermal energy purposes (heating of kilns). Their use for power generation is limited because of comparatively cheap electricity supplies. Future developments will depend upon relative price trends for wood and energy and on improvements in conversion technology. A general response to higher prices is to aim at increased use of processing residues and materials currently left standing or down in the forest (e.g. whole tree harvesting).

Since 1974, much research and development work has been done in order to improve the economy of wood processing industries. In the developed countries, this work has been focussed on revealing the energy saving potentials, application of saving measures and on development of technology and machinery consuming less energy. Considerable savings can usually be achieved, the main potentials lying in improved conduction and maintenance of kilns and driers and use of exhaust heat.

Even though fuel is by far the main use of wood in developing countries, wood residues are used very little as an energy source in the wood processing industries. One of the reasons is the minimal use of artificial drying in sawmills. However, the industry in the developing countries could make better use of the opportunities to increase their energy self-sufficiency by utilizing the otherwise unused waste and to replace diesel generators. Solar kiln drying is still not widely practiced and, at present energy prices, not yet competitive with conventional techniques. Specifically, it is necessary to develop techniques for heat storage overnight to reduce total drying time and thereby costs for a given throughput.[39]

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[39] For further information, see G.S. Hall et. al, The Art of Timber Drying with Solar Kilns, UNIDO, ID/WG.338/1, 1981.

Possibilities for the developing countries in the energy field are:

- increasing efforts to develop simple and economical power production equipment (utilizing wood residues) appropriate to small-scale industries;
- distributing information and providing technical assistance on energy aspects and energy saving actions; and
- including energy aspects in the technical training for technical personnel.

3.7 Research needs

The wood processing industries are a relatively low-technology field in comparison to many new, fast developing industries. Therefore, the total research input, either by the public or private sector, has remained very low.

As to future development, the wood processing industry is characterized by great advantages from the point of view of national economies: it uses renewable natural resources, requires little energy for the production and is essentially self-supporting in this respect. It is relatively labour intensive and scale economies are not necessarily pronounced. Therefore an increasing share of public research funds should be directed to the field. The same goes for the use of wood in construction and also as a source of energy.

The lack of research and development in the developing countries is one of the many constraints on the development of wood processing industries in these countries. The technology developed for the conditions in the developed countries or temperate zones can often be inappropriate when transferred to the developing countries and to tropical conditions. Therefore, adaptations and modifications may be required to match the needs of these countries. An optimal solution would in many cases be a technology that was originally aimed at solving the problem identified in the developing countries. Much information is available on properties and possible uses of tropical woods in laboratories and research institutes in the industrialized countries. Such information should be disseminated and made full use of in both developed and developing countries. It is, however, even more important that the research effort be extended to the developing countries themselves. Research and development could to a much larger extent begin in laboratories near the forest resources.

There is a great need to increase the research efforts focussed on the needs of the developing countries for the development of wood processing industries and wood utilization, and to increase both international input and regional cooperative efforts in the field. A world-wide census of the ongoing research activities and existing research structures should be conducted and an appropriate international cooperation framework built.

Some of the most important research and development areas are:

- Forest management and reforestation techniques in the tropical countries to secure the future raw material for the industries. This should include research directed toward producing better forest inventories, especially with regard to presently commercially less accepted species;
- Industrial uses of a greater proportion of the total wood volume per hectare of forest. This should include developing end-use applications, processing technology, and marketing strategies for the use of commercially less accepted species as well as for the use of waste material from wood processing;
- The grouping of species in terms of similar processing requirements, in terms of similar structural properties, and in terms of similar wood preservation techniques;
- Developing and adapting technology to the special circumstances of developing countries, such as relatively high costs for capital and skilled labour, and (usually) non-wood raw materials vs. low costs for wood raw materials (especially commercially less accepted species and processing wastes) and unskilled labour. These research and development issues relate not only to the wood sector itself but also to the allied industries which supply the services and materials used in the wood sector as well as other sectors. The strengthening of these sectors would strengthen the wood sector as well as promote balanced economic development.

CHAPTER 4. International Trade in Wood and Wood Products

4.1 General characteristics

4.1.1 Analysis of main trade flows

An analysis of the trade flows brings out the following main characteristics:

(i) Trade between developing and industrialized countries:

(a) The flow of the vast bulk of this international trade is dominated by exports from the South to the North.

(b) The product-mix involved in this part of the international trade consists mainly of: (i) sawlogs and veneer logs of non-coniferous species; (ii) sawnwood of non-coniferous species; and (iii) wood based panel products. In the last category, veneer sheets and plywood, largely made of non-coniferous species, are the most important products, insofar as the exports of developing countries are concerned.

(c) An important and increasing flow is in coniferous sawnwood from North Europe to North Africa and the Middle East.

(ii) Trade among industrialized countries:

(a) The main flows are between North America and Europe; within Europe itself, particularly among the countries of the European Economic Community; and the trade flows between North America and Europe on the one hand, and Japan, on the other;

(b) most of this intra-trade is made up of wood and wood products consisting of, or based on mainly coniferous wood species;

(c) the product-mix ranges widely from industrial logs, including sawlogs and veneer logs, to sawnwood, wood based panels, pulpwood and pulp to builders' woodwork, furniture and other finished products;

(d) the turnover in this intra-trade, in terms of both volume and value, exceed by far the turnover in the North/South trade.

(iii) Trade among developing countries:

Trade of wood and wood products among developing countries is rather low, in particular intra-African trade and trade between Africa and the other developing regions. On the other hand, trade among Asian and Latin American developing countries is increasing progressively, mainly due to regional co-operation and preferential trade arrangements. Trade among developing countries in 1979 amounted to about 12 per cent of total world trade in wood in the rough, 7 per cent in plywood and veneers, and about 1 per cent in furniture.

The main obstacles to trade among developing countries are trade barriers (tariff and non-tariff) and the lack of marketing organizations and trade promotion councils for wood products.

4.1.2 Patterns and flows in world trade in wood

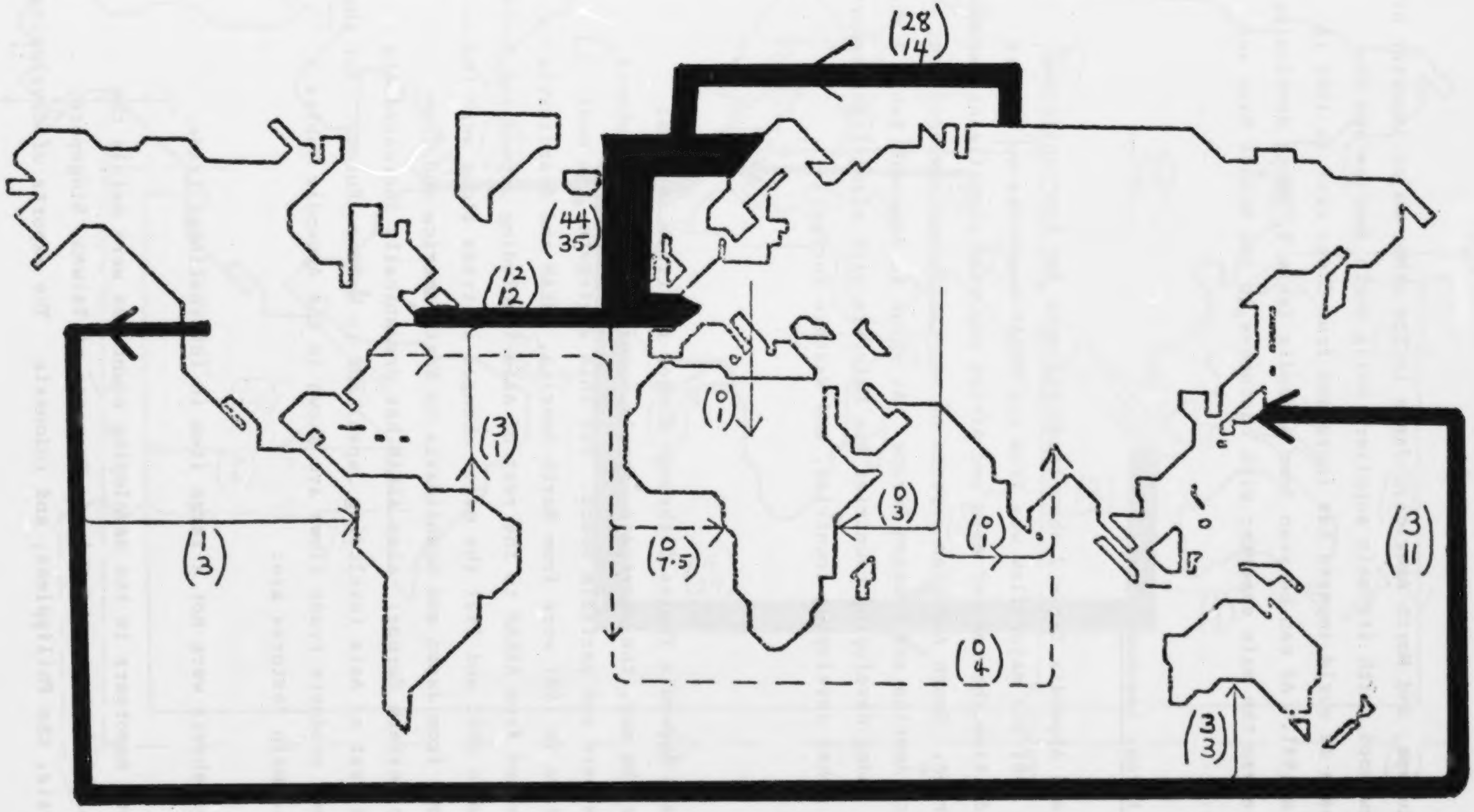
Maps 4.1 through 4.5 show trade patterns for selected products in the year 1981.[40/] Additional information is provided by the Direction of Trade tables in the Appendix.

Coniferous sawnwood

Map 4.1 and Appendix Table 1 show the trading patterns for coniferous sawnwood. In 1981 Western Europe was the largest importer by far. The main sources of Western Europe's imports were the Scandinavian countries, the USSR

[40/] Based on a study that will be issued jointly by the Sectoral Studies Branch of UNIDO and IIASA, the products are: (SITC revised numbers within brackets) Coniferous sawnwood (243.2), non-coniferous sawnwood and sleepers (243.3 and 243.1), panels and veneer (631.1 and 631.2 and 634.2 and 641.6), furniture (821.0) and builders woodwork (632.4).

The eleven geographic groupings are: North America, Japan, the Nordic countries, Western Europe, Eastern Europe (including Yugoslavia) plus the USSR, Oceania, South Africa, Africa (excluding South Africa), Latin America, ASEAN, rest of Asia. Note that trade within a region is not included.


$\binom{28}{14}$
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$\binom{3}{1}$
$\binom{1}{3}$
$\binom{0}{1}$
$\binom{0}{7.5}$
$\binom{0}{3}$
$\binom{0}{1}$
$\binom{0}{4}$
$\binom{3}{11}$
$\binom{3}{3}$

Map 4.1 : Coniferous Sawnwood: trade flows greater than 1% in 1981, with $\binom{1962}{1981}$ shares of world trade shown

------ flow >1% only since the early 1970s or later and Eastern Europe, and North America. Japan is the other major importer of coniferous sawnwood, with its main suppliers being North America and the USSR. Its share of world imports has increased from 3 per cent in 1962 to 12 per cent in 1981. As can be seen from Appendix Table 3, among developing regions, Chile was the main exporter with customers in the Middle East and Latin America.

Non-coniferous sawnwood

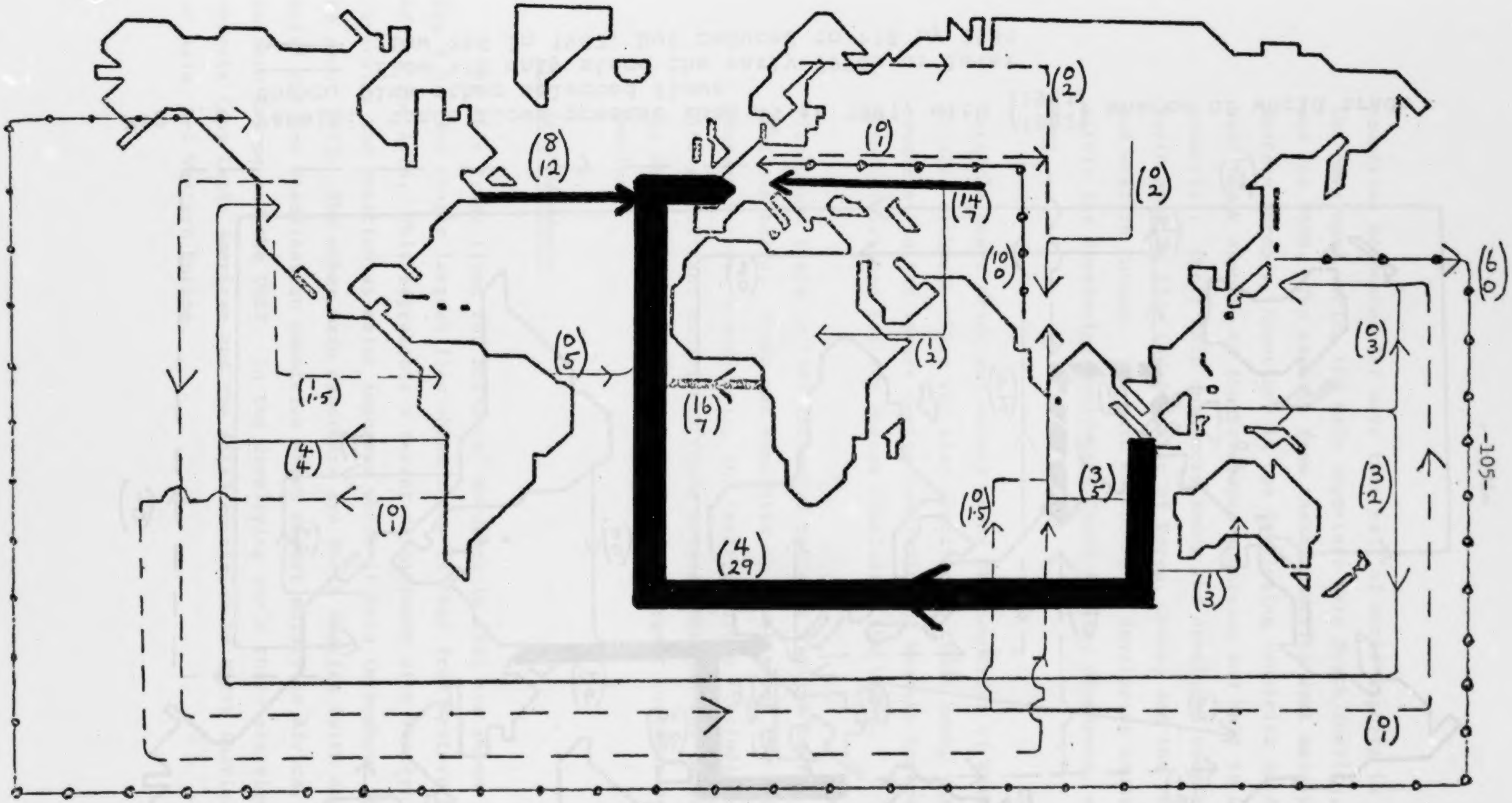
Map 4.2 and Appendix Table 2 show trade patterns for non-coniferous sawnwood. In 1981 the major flow was from the ASEAN countries to Western Europe. In addition the rest of Asia and Africa exported significant amounts to Western Europe. South American exports of non-coniferous sawnwood went mainly to North America and Western Europe. As shown in Appendix Table 2 the main exporter among developing countries was Malaysia with significant exports to Singapore, other developing countries, and Western Europe.

Panels

Map 4.3 and Appendix Tables 5 through 8 show the trade in panel products. For the map, the aggregate "panels" consists of veneer sheets, plywood, fibreboard and particle board. For this aggregate, the most significant flows in 1981 were from North America, ASEAN and Scandinavia to Western Europe and from ASEAN to the rest of Asia (excluding Japan) and North America. Between 1962 and 1981 the major changes in trade flows were the decline in flows from Japan and Scandinavia to North America and from Scandinavia to Western Europe; also ASEAN has dramatically increased its exports to the rest of Asia (excluding Japan) and to Western Europe. For the individual panel products trade flows are shown in the Appendix Tables 5 through 8. The main features are:

- Veneer sheets were not a large item in international trade.

- Plywood exporters in the developing countries were mainly the Republic of Korea, the Chinese Province of Taiwan, Singapore, Malaysia, the Philippines, and Indonesia. The exports of developing



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$\binom{14}{7}$
$\binom{10}{0}$
$\binom{6}{0}$
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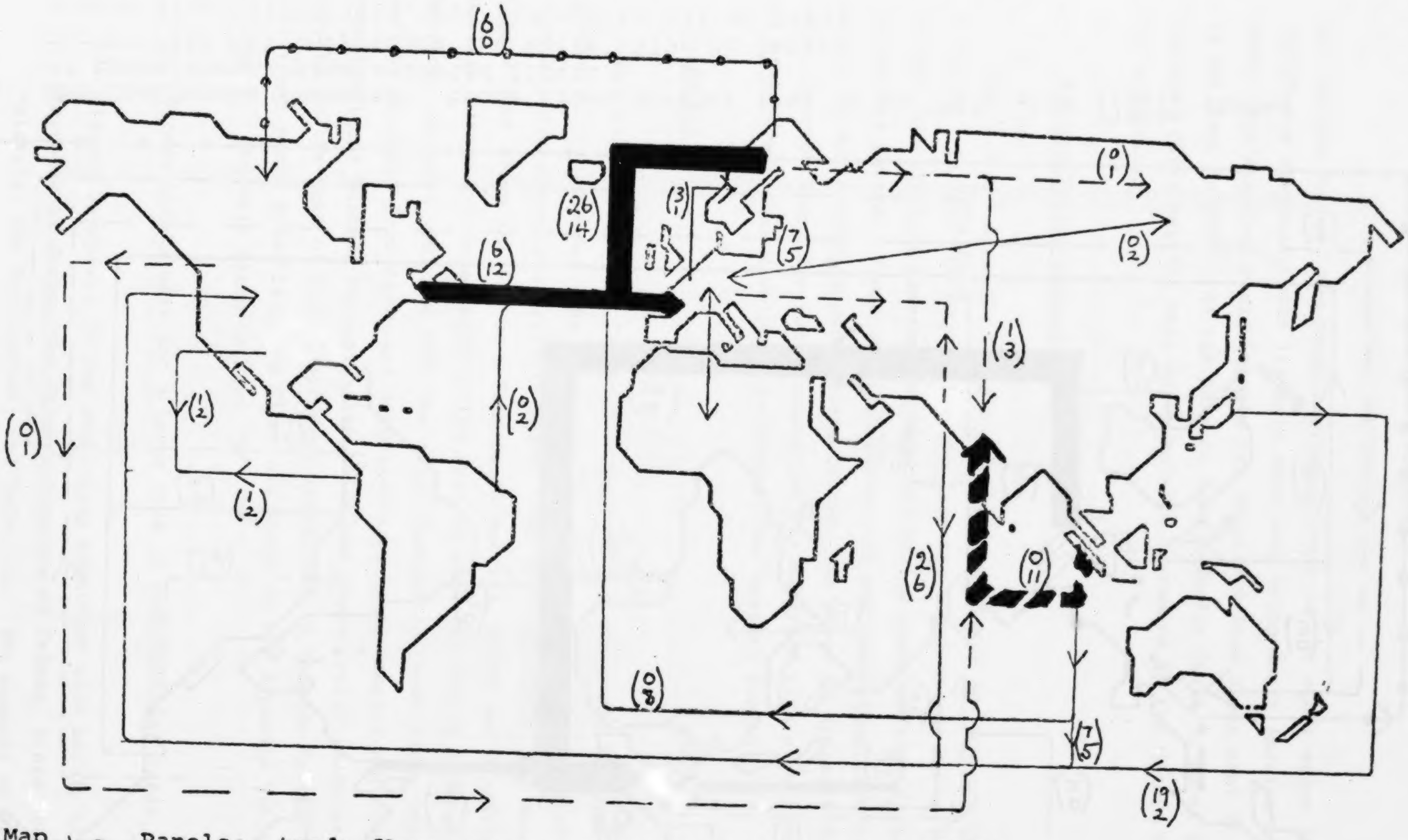
$\binom{4}{4}$
$\binom{3}{5}$
$\binom{3}{2}$
$\binom{0}{1}$
$\binom{0}{1.5}$
$\binom{4}{29}$
$\binom{1}{3}$
$\binom{0}{1}$

Map 4.2: Non-Coniferous Sawnwood: trade flows greater than 1% in 1981, with $\binom{1962}{1981}$ shares of trade shown, plus selected flows.
------ flow > 1% only since the early 1970s or later
—•—•—•— flow > 5% in 1962, but reduced to >1% by 1981


(6 / 0)
(26 / 14)
(3 / 1)
(7 / 5)
(6 / 12)
(0 / 1)
(0 / 2)
(1 / 3)
(0 / 1)
(1 / 2)
(0 / 2)
(1 / 2)
(2 / 6)
(0 / 11)
(0 / 8)
(7 / 5)
(19 / 2)

Map 4.3: Panels: trade flows greater than 1% in 1981, with $\begin{pmatrix}1962\\1981\end{pmatrix}$ shares of world trade shown, plus other selected flows.

------ flow >1% only since the early 1970s or later

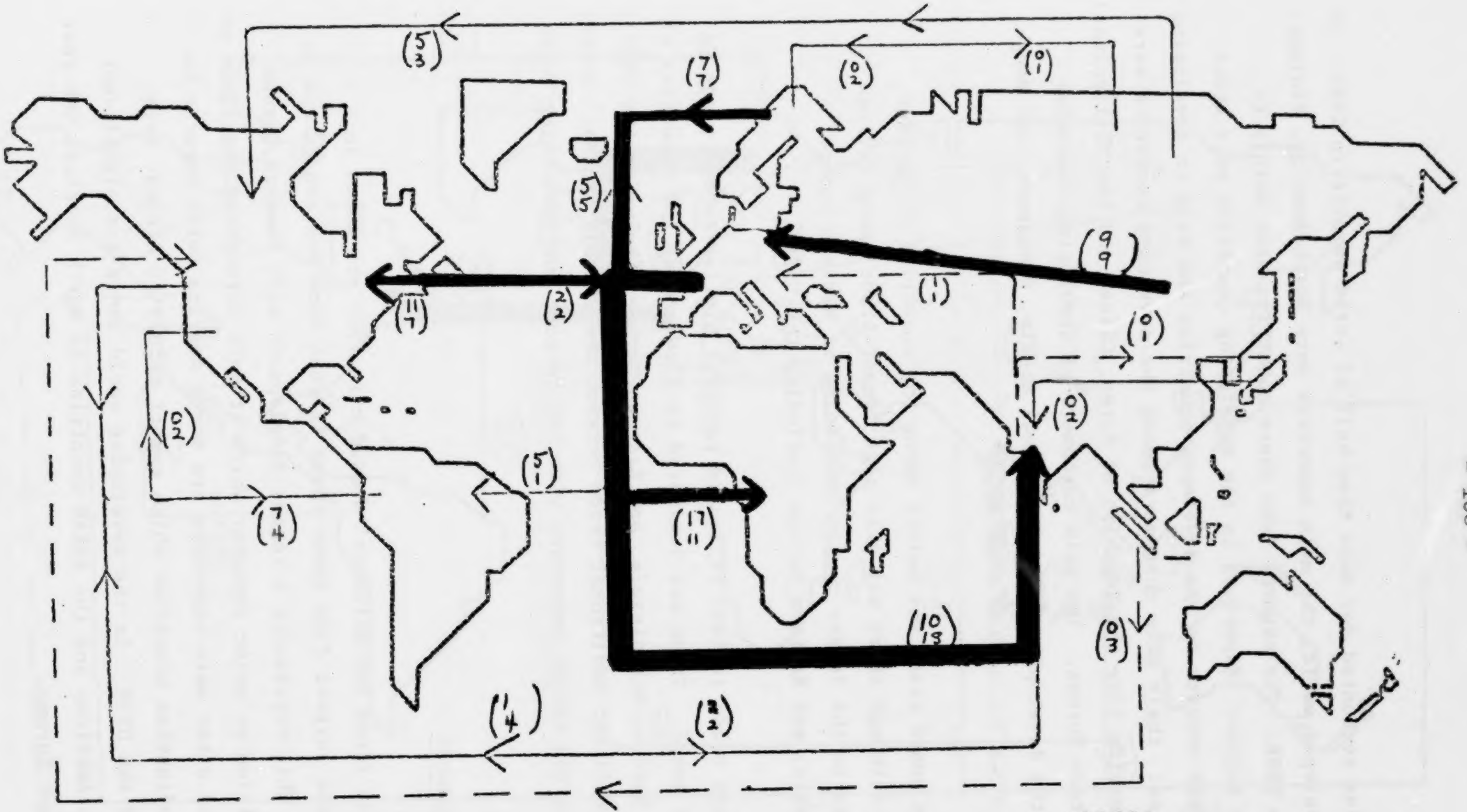
-•-•-•- flow >5% in 1962, but reduced to >1% by 1981 countries accounted for more than half of world exports in 1981. In the developed world, the main exporters were North America, Finland, and the USSR. The exports from these countries went mainly to Western Europe. Exporters in the developing countries sold about half their exports to the developed countries and half to developing countries; their main customers among the developed countries were North America (for the Republic of Korea, China, and the Philippines) and Western Europe. The main customers of developing countries within the developing world were Saudi Arabia, Singapore, and Hong Kong.

- Particle board trade was mainly among the countries of Western Europe, although there was also significant trade among various countries in the larger region consisting of Western Europe, Scandinavia, and Eastern Europe (including the USSR).

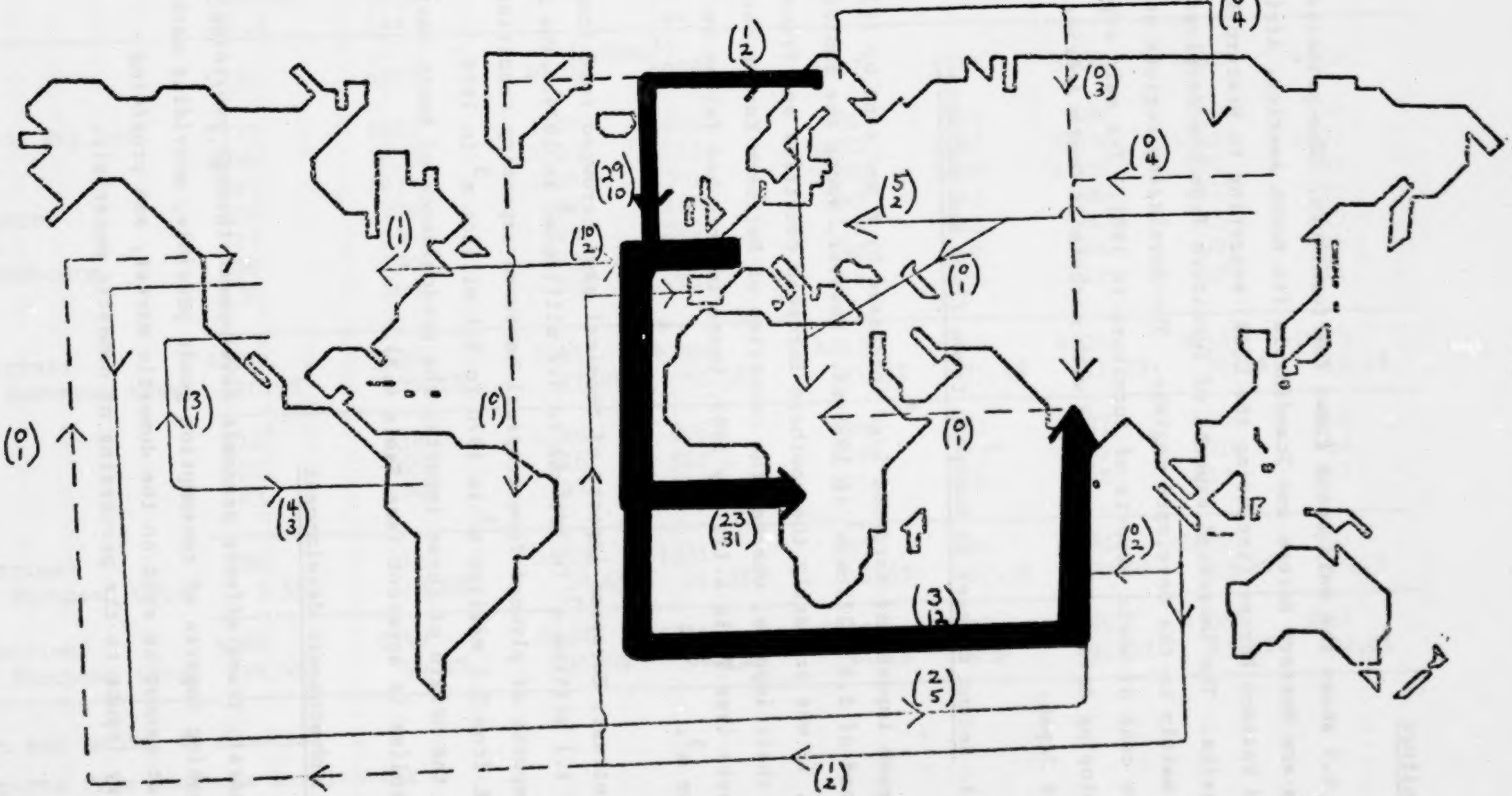
- Fibreboard trade in 1981 reflected patterns similar to the trade in particle board. Trade was dominated by flows among the countries of Western Europe, Scandinavia, and Eastern Europe (including the USSR); with significant additional trade between the USA and Canada. Brazil was among the larger exporters with its largest customer being North America.

Builders' Woodwork

The main trade flows for Builders' Woodwork in 1981 are shown in Map 4.4. The single largest flow shown there is that from Western Europe to Africa and Asia. This represents a recent development with Western Europe reversing the position as major importer which it held throughout the 1960s up to about 1973. The other main exporters are North America (with exports to Asia) and the Scandinavian countries which export mainly to Africa, Asia, Eastern Europe and the USSR. In the developing world there are significant exports from Latin American and the ASEAN countries to North America, the rest of Asia, and Western Europe.


$\binom{5}{3}$
$\binom{7}{7}$
$\binom{0}{2}$
$\binom{0}{1}$
$\binom{5}{5}$
$\binom{9}{9}$
$\binom{1}{1}$
$\binom{11}{7}$
$\binom{2}{2}$
$\binom{0}{1}$
$\binom{0}{2}$
$\binom{0}{2}$
$\binom{5}{1}$
$\binom{7}{4}$
$\binom{17}{11}$
$\binom{10}{13}$
$\binom{0}{3}$
$\binom{1}{4}$
$\binom{2}{2}$

Map 4.4: Furniture: trade flows greater than 1% in 1981, with $\binom{1962}{1981}$ shares of world trade shown.
------ flow >1% only since the early 1970s or later


(0 4)
(1 2)
(0 3)
(0 4)
(29 10)
(5 2)
(1 1)
(10 2)
(0 1)
(0 1)
(3 1)
(0 1)
(0 1)
(4 3)
(23 31)
(0 2)
(3 12)
(2 5)
(1 2)

Map 4.5: Builders' Woodwork: trade flows greater than 1% in 1981 with $\binom{1962}{1981}$ shares of world trade shown.
------ flows >1% only since the early seventies or later

Furniture

Map 4.5 shows the main trade flows for furniture. The principal exporters are Western Europe and Scandinavia (to North America, Africa, and Asia) and Eastern Europe (including the USSR) exporting to Western Europe and North America. The increased exports of furniture from the developing regions has been mainly to the developed regions. The developing regions accounted for 11 per cent of world exports of furniture in 1981. The main exporters were developing Asia and Latin America with markets in North America, Western Europe and Japan.

4.1.3 Recent changes in European trade flows and patterns

European imports of hardwood logs increased by 8 per cent by 1979 from an average load of 5.3 million m^3 in 1964-66. However, among the individual countries, it was primarily the southern European countries and France that increased their imports, whereas the countries of Northern Europe decreased their imports (see Table 4.1). By 1982, these imports had fallen to 4.3 million m^3.

In contrast, European imports of tropical sawn hardwood rose from an average of 1.1 million m^3 in 1964-66 to 3.7 million m^3 in 1979. The ECE region's imports of plywood from tropical hardwood exporting countries rose by 40 per cent from 2.1 million m^3 in 1970 to 3.1 million m^3 in 1979. Looking at the origin of these imports, the predominance of South East Asian plywood supplies is apparent (see Table 4.2).

4.2 Trade and economic development

In general, trade affects economic development through providing foreign exchange, making imports of consumption goods possible, providing markets for products that cannot be sold on the domestic market, and providing complementary inputs to the processing of domestic materials.

Table 4.1. Europe: Trends in imports of tropical hardwood logs by major importing countries

	1964-66 (av.)	1969-71 (av.)	1973	1974-76 (av.)	1978	1979	1980	1981	1982
			(1000m³)						
EUROPE, total	5299	6707	9401	6068	5317	5742	5868	4600	4300
of which:									
Germany, Fed. Rep. of	1577	1461	1507	920	832	819	774	552	512
France	1334	1638	2803	1518	1570	1698	1714	1412	1271
Italy	891	1474	1924*	1301	1090	1388	1276	981	895
United Kingdom	426	279	297	186	190	141	96	64	70
Netherlands	273	294	404	249	178	161	160	115	119
Belgium-Luxembourg	190	190	243	175	139	126	144	99	95
Denmark	130	103	63	41	14	11	12	10	11
Total (7 countries)	4820	5438	7241	4390	4013	4344	4176	3233	2973
Percentage of European total	90.9%	81.1%	77.0%	72.3%	75.5%	75.7%	71.1%	70.3%	69.1%
Spain	111[a]	672	1140	826	534	561	737	408	350
Portugal	51	165	416	310	228*	153*	285	451	400
Greece	23	74	197	185	225	280	267	213	241
Total (3 countries)	186	911	1753	1321	987	994	1289	1072	991
Percentage of European total	3.5%	13.6%	18.6%	21.8%	18.6%	17.3%	22.0%	23.3%	23.1%
Total (10 countries)	5006	6349	8994	5711	5000	5338	5465	4305	3964
Percentage of European total	94.4%	94.7%	95.6%	94.1%	94.1%	93%	93.1%	93.6%	92.2%

Totals may not add up due to rounding

[a] Excluding imports from overseas territories

Source: T.S. Peck, Introduction in Tropical Hardwood Utilization, Roelof A.A. Oldeman (ed.) Martinus Nijhoff, The Hague, 1982, p.6., and T.S. Peck (personal communication, 1983-07-25)

Table 4.2 Europe and North America: Imports of plywood, by country groups from major tropical hardwood exporting regions
($1000m^3$)

	1970	1973	1974	1975	1976	1979
Europe, total of which, from:	348	782	469	498	820	1222
Africa	99	133	62	63	80	67[b]
Asia	159	468	225	322	563	851[b]
Latin America	23	37	17	26	37	54[b]
Other[a]	67	144	164	87	140	250[b]
North America, total of which, from:	1809	2333	1597	1833	2195	1821[b]
Africa	-	-	-	-	-[b]	- [b]
Asia	1046	1444	965	1198	1445	1039
Latin America	3	6	8	4	5	22[b]
Other[a]	760	883	624	631	745	760[b]

Source: T.J. Peck, *ibid*, page 11

[a] Countries of the three exporting regions, but not specified.

[b] ECE Secretariat estimate.

Provided that a country can sufficiently add value by either processing the imported material as such or combining it with domestic resources, import can be profitable. In the wood sector, the Republic of Korea, Japan, the Chinese Province of Taiwan, Singapore, Algeria, Argentina, Egypt, even Malaysia and Finland provide diversified cases in point. Put differently, the feasibility of a domestic wood processing industry may depend in a crucial way on imports.

Exports, of course, provide much needed foreign exchange and many countries have indeed resorted to the export of raw materials, including saw and veneer logs, precisely for this reason despite a long term desire to further process the material at home. If the so accumulated export earnings are invested in domestic activities, including industry, the policy can contribute to growth and industrialization. This implies that there are profitable domestic investment opportunities and that government policies are conducive to such investment. Otherwise, the export earnings go to consumption or flee the country. Thus, investment policy in the wood sector ties in with the general investment policies of the exporting country.

The domestic or regional market, especially in a sector such as the secondary processing sector, is for a developing country often far more important than the export market, provided that the former is large enough, for the following reason:

(a) the sophistication of processing, can be geared to local resources and skills;
(b) the product design in secondary processing can be suited to domestic traditions, tastes and requirements that are far better known than those of foreign countries;
(c) the products manufactured can be selected to form import substitutes or complements to imports or other domestic products;
(d) quality requirements and the meeting of standards for export may exceed realistic domestic possibilities, whereas the achievable quality is acceptable on the domestic market;
(e) producing for the domestic market can be achieved using skills that are more compatible with the locally existing skill levels while at the same time providing opportunities for the local population to gain experience in "technical tradition"; management skills requirements are also less;
(f) domestic materials from lesser known species and/or of lesser quality than required on the overseas export market can be used in products intended for domestic consumption;
(g) the scale of activities are often better suited for the available domestic capital, and
(h) the growth in domestic demand through both demographic and income effects is important for the stability of the domestic industry and the reduction in reliance on fickle exports.

Therefore, both in international co-operation and in domestic policies of the developing countries themselves, much more attention must be paid to building up the domestic markets for wood products than hitherto has been the case.

It must be recognized that many small countries and island states like those in the Caribbean and South Pacific are not in a position either because of a lack of the basic infrastructure, complementary industries, or a small domestic market to embark on sophisticated wood processing on their own.

4.3 Tariff and non-tariff barriers[41]

Like the trade in most other product categories, international trade in wood and wood products is regulated and controlled by the means of various trade measures. In particular, the importing countries rely for the control and protection of their domestic markets on two categories of measures: tariffs, supplemented by additional fiscal duties, and non-tariff measures. This second category is particularly varied, with measures ranging from traditional and simple volume restraints (like quotas) to sophisticated devices with a multitude of objectives and effects such as, for example, the variable levy. Since the protective effect generated nowadays by tariffs is rather low due to the series of multilateral negotiations, and since tariffs are difficult to manipulate in a quick and efficient manner owing to legal constraints, the importing countries rely increasingly in their trade policies on numerous non-tariff measures.

The wood and wood products of developing countries face tariff barriers, see Table 4.3. The extent of such barriers and their effect upon an exporting country depends upon the product, the exporting country and the importing country. Even for the same product, such as plywood or builders' joinery or some specific product based upon wood, the tariff rate may differ

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[41] This section is based on an analysis by the UNCTAD Secretariat "Tariff and non-tariff measures in World Trade of Wood and Wood Products", UNIDO/IS.396, which is issued separately.

Table 4.3 Summary view of the post/MTN tariff situation and non-tariff affecting tropical hard wood and hard wood products of interest to developing countries as of 1983

Explanatory notes and symbols used

This summary table does not indicate duties on products of nil or limited interest to developing countries

[ ] = GSP treatment limited by quotas or ceilings

SPARTECA = South Pacific Regional Trade and Economic Agreement

DPC(Australia) = Declared Preference Countries (These are mostly the developing Commonwealth countries, except India, Pakistan, Papua New Guinea)

** = The ad valorem rates shown for Switzerland are ad valorem incidences of specific duties based on import data for 1976 or 1977. It may be noted that incidence of specific duties may fluctuate from year to year.

* = Ad valorem incidence of specific duties based on import data for 1976 or 1977 in the Tariff Study file. It may be noted that incidence of specific duties may fluctuate from year to year.

NTM = Non-tariff measures

QR = Quantitative import restrictions

PNG = Papua New Guinea

AGP = African,Caribbean and Pacific (Ocean) countries associated with the EEC under the Lome Convention of least-developed countries(LLDC) have unrestricted duty-free entry to the EEC market for all the items listed.

SITC Rev.1	Product description	Australia	Canada	EEC	Japan	New Zealand	Switzerland	USA
242.1	Wood, in the rough, whether or not stripped of its bark or merely roughed down. Of non-coniferous species	0%	0%	0%	0%	0%	0% (tropical wood)	0%
242.2	Wood roughly squared but not further manufactured. Of non-coniferous species	0%	0%	0%	0%	0%	0% (tropical wood)	0%
242.3	Wood sawn lengthwise, sliced or pealed but not further prepared. Of non-coniferous species	See Note 1	0%	0%	10%,GSP 5%2/ LLDC 0%, Other 0%	mfn 0% (tropical wood)	0% (tropical wood)	0%
243.1	Railway or tramway sleepers of wood	mfn 5% DPC 5% less 50.43/m3 PNG 0%	0%	mfn 2.9%, 4.7% GSP 0%, 0%	0%	mfn 10% GSP 0%	mfn SWF0.0095/kg SWF0.0157/kg GSP 0%	0%
242.9	Hoopwood, split poles, piles, pickets, stakes, etc. Of non-coniferous species	mfn 15% GSP 0%	0%	mfn 2.4-4.4% GSP 0%	0% 7.5%, GSP [0%] 5%, GSP 0%	0%	mfn 3.3% GSP 0%	0%
243.3	Wood (including blocks, strips and friezes for parquet or wood block flooring not assembled), planed, tongued or grooved, rebated, etc.	See Note 1	mfn 0%, 5.5% GSP 0%, 4%	mfn 4% GSP [0%] ACP 0% LLDC 0%	mfn 0%, 10% GSP [0%]	mfn 10% GSP 0% NTM QR3/	mfn 3.2%, 6.5% GSP 0%, 0%	0% mfn 0%, 3.2% GSP 0%
631.1	Veneer sheets and sheets for plywood (sawn, sliced or peeled, etc.)	mfn 15%1/	mfn 0%	mfn 6% GSP [0%] ACP 0% LLDC 0%	0%; 15%, GSP [7.5%]; LLDC 0% 8%, GSP [0%]	mfn 30% GSP 20% SPARTECA 0% NTM QR 3/	mfn 1.8%, 2.4% GSP 0%, 0%	0% mfn 0%, 3.2% 4%

Note 1: Various tariff and non-tariff measures apply, see source document for details.

1/ Cut to size for making boxes; mfn 0% + 2% fiscal duty, GSP 0%; Other,of balsa mfn 15%, GSP 0%.

2/ Duties on Lauan, Kruing, Mersawa (and other Dipterocarpaceae family) wood sawn lenghhwise, not further worked.

3/ Other than balsa wood.

Table 4.3 (continued)

SITC Rev.1	Product Description	Australia	Canada	EEC	Japan	New Zealand	Switzerland	USA
631.2	Plywood, blockboard, laminboard, battenboard and veneered panels, etc., of non-coniferous species.	See Note 1	mfn 4%,8%,9.2? GSP -,3-7%,5%	mfn 10% GSP $\boxed{0\%}$ ACP 0% LLDC 0%	mfn 15% 17%,[4] 20% [4] mfn 20%) GSP $\boxed{0\%}$) Other	mfn 20%,35% [4] [4] GSP 10%,25% [4] SPARTECA 0% NTM QR	mfn 5.4-7.4% GSP 0%	mfn 4-6% GSP partly 0% See Note 2
631.8	Wooden beadings and mouldings including moulded skirtings and other moulded board.	mfn 22.5% PNG 0% SPARTECA 0%[1]	mfn 6.8% GSP 5%	mfn 3% GSP 0%	mfn 7.2% GSP 0%	mfn 20% GSP 10% SPARTECA 0% NTM QR	mfn 3.7-10.6% GSP 0%	mfn 0%, 4.5% GSP 0%
632.7	Wooden picture frames, photographic frames, mirror frames and the like.	mfn 22.5% GSP 10% PNG 0% SPARTECA 0%[1]	mfn 9.2% GSP 7.5%	mfn 5.1% GSP 0%	mfn 6.5% GSP 0%	mfn 20% GSP 10% SPARTECA 0% NTM QR	mfn 3.3%,4.7% GSP 0% 0%	mfn 2.4% GSP 0% See Note 2
632.1	Complete wooden packing cases boxes, crates, drums and similar packings.	mfn 15%,25% [2] [2] GSP 0%,15% SPARTECA 0% [2]	mfn 15% GSP 10%	mfn 6.9%,7.5% GSP 0%	mfn 4.2% GSP 0%	mfn 0%,10% GSP 0% SPARTECA 0% NTM QR [5]	mfn 1.7%,4.7% GSP 0% , 0%	mfn 0%, 7.7% 16.7% GSP -, 0% 0%
632.2	Casks, barrels, vats, tubs, buckets and other cooper's products and parts, etc.	See Note 1	See Note 1	mfn 2.9%,4.1% GSP 0%	mfn 4.2% GSP 0%	mfn 0%,10% GSP 0% SPARTECA 0% NTM QR[5]	mfn 3.4% GSP 0%	mfn 0%, 2.8% 5.1% GSP -, 0% 0%
632.4	Builders' carpentry and joinery.	mfn 15%,22.5%[3] GSP 10% [2], - PNG 0% SPARTECA 0%[1]	See Note 1	mfn 4.1%,6%, 7.5% GSP $\boxed{0\%}$ ACP 0% LLDC 0%	mfn 0%,4.9% GSP $\boxed{0\%}$	mfn 20% GSP 10% SPARTECA 0% NTM QR[6]	mfn 2.2-5.1% GSP 0%	mfn 3.2-16.7% GSP partly 0% See Note 2
632.7	Household utensils of wood	mfn 15% GSP 0% SPARTECA 0%	See Note 1	mfn 3% GSP $\boxed{0\%}$ ACP 0% LLDC 0%	mfn 7% GSP 0%	mfn 30%,30% GSP 15%,20% SPARTECA 0% NTM QR	mfn 4.2% GSP 0%	mfn 4.5-10.1% GSP partly 0% See Note 2
632.8	Wooden tools, tool bodies, tool handles, broom and brush bodies, etc.	mfn 15%,22.5% SPARTECA 0%	See Note 1	mfn 4.6%,6% GSP $\boxed{0\%}$ ACP 0% LLDC 0%	mfn 3.2%,4.2% GSP 0% , 0%	mfn 0%,5%,20% GSP . 0%,10% SPARTECA 0%	mfn 2.5%,3.7% GSP 0%. 0%	mfn 0% 4.4%-8% GSP 0%

[1] Made from exotic, non-competitive timber species.

[2] Of fibre building board

[3] Louvred good

[4] Duty rates applicable to plywood

[5] Complete wooden packing cases, boxes, etc (excluding returned empty containers), casks, barrels, vats, etc., of wood (excluding those in CCCN, Item Code 44,000).

[6] Structural building units composed of laminated wood; beams, rafters, roof trusses and like structural timber in an unassembled or disassembled condition, not being goods of plywood, cellular wood, improved wood or reconstituted wood; other.

Note 1: Various tariff and non-tariff measures apply, see source document for details.

Note 2: See source document for additional details.

Table 4.3. (continued)

SITC Rev.1	Product Description	Australia	Canada	EEC	Japan	New Zealand	Switzerland	USA
632.8	Spools, caps, bobbins, sewing thread reels, etc.	mfn 15% GSP 0%	See Note 1	mfn 2.5% GSP 0%	mfn 4.2%, 4.8% GSP 0%, 0%	mfn 10% GSP 0%	mfn 3.3% GSP 0%	mfn 5.1% GSP 0%
632.7	Lamps, trays, fruit bowls, etc, ornaments and adornments of wood, etc.	mfn 15%, 21% 1/ GSP 0%, 10% 1/ SPARTECA 0% 1/	See Note 1	mfn 5%, 6% GSP 0%	mfn 4%, 12% GSP 0%, 0%	mfn 30% GSP 15% SPARTECA 0% NTM QR	mfn 3.7-5.9% GSP 0%	mfn 3%-11% GSP partly 0% See Note 2
632.8	Other articles of wood, n.es.	mfn 15% GSP 0%, 2/ SPARTECA 0%	See Note 1	mfn 2.9-7.5% GSP 0%	mfn 5.7%, 5.8% GSP $\boxed{0\%}$, 0%	mfn 30% GSP 20% SPARTECA 0% NTM QR 3/	mfn 1.1% -4.6% GSP 0%	mfn 0%-16.7% GSP partly 0% See Note 2
821.0	Chairs and other seats of wood.	mfn 30% GSP 20% (by-law items only PNG 0%	See Note 1	mfn 5.6% GSP $\boxed{0\%}$ ACP 0% LLDC 0%	mfn 4.8%, 5.4% GSP 0% $\boxed{0\%}$	mfn 40% GSP 22.5% SPARTECA 0%	mfn 1.7-16.2% GSP 0%	mfn 2.5-6.6% GSP partly 0% See Note 2
821.0	Other furniture and parts thereof. of wood.	mfn 30% GSP 20% (by-law items, etc) PNG 0%	See Note 1	mfn 5.6% GSP $\boxed{0\%}$ LLDC 0%	mfn 4.8%, 5.7% GSP 0% $\boxed{0\%}$	mfn 40% GSP 22.5% SPARTECA 0%	mfn 0.2-14.3% GSP 0%	mfn 2.5%, 4% 5.3% GSP 0%

1/ Fans and handscreens, non-mechanical and frames and handles and parts thereof for fans and handscreens.

2/ Other than paving blocks.

3/ Rollers for spring blinds; beehives and frames therefor including unassembled components, etc; shingles; planar forms of wood jointed lengthwise along the edge, tongued and grooved, etc.

Note 1: Various tariff and non-tariff measures apply, see source document for details.

Note 2: See source document for additional details.

Source: GATT, Tropical Products: Information on the commercial policy situation and trade flows - Tropical wood and wood products, COM.TD/W/345, 1981.

substantially from one importing country to another and for one exporting country to another. Moreover, the effect of a given trade barrier varies with the relevant import and export elasticities. Thus, detailed generalizations are, as a rule, not realistic.

There have been international negotiations such as the negotiations in UNCTAD and GATT where developing countries try to get certain existing tariff levels reduced or removed by their developed country partners. Each developed country has it own policy in relation to the product under negotiation, which is why there is seldom, if ever, a blanket reduction on a product category which is sensitive. Even where some relief has been given and a tariff barrier has been reduced, some other barriers may remain at the discretion of the importing country so that it may retain control on the quantity of the imports or the price levels in order to protect its own industrial sector involved in producing the same product category or a similar product.

Plywood is an especially sensitive product, but the sensitivity varies with both exporting and importing country. The EEC allows duty free entry of plywood to members states of the ACP (African, Caribbean and Pacific) countries under the Lomé Convention. On the other hand, there is a quantitative ceiling which applies to non-Lomé Convention countries. Each year, a ceiling is fixed as to the volume of plywood which may enter the EEC countries, duty free, under the Generalized System of Preferences (GSP). The United Kingdom is generally allocated the bulk of the volume of plywood imports duty free under the GSP. But, the year's limit is often reached in the first quarter of the year. Perhaps even more important, there seems to be no way of an exporting country knowing whether or when the ceiling is reached. Clearly, this implies serious commercial constraint and risk.

In permitting the raw material e.g. logs or rough timber to enter duty free, an importing country does in fact give an advantage to its local industries which increases the effective rate of protection. This is so because a processed product, say plywood, in the importing country gets to keep all the value added from the processing whereas a producer in the log-exporting country has to pay a customs duty that, in effect, applies entirely to the value added since unprocessed logs could have been entered duty free. In the case of plywood in Japan, it has been estimated that this effective protection amounts to over 60 per cent[42/]. Clearly, the proportion of the cost input of the raw material in the manufacture affects the percentage of effective protection.

The categories in wood products that are geared for volume and value are sawnwood and panel products. The latter continues to face severe barriers despite that, for technical reasons, it is classified as a "primary" product (see Table 4.4). Moreover, it has been said that the manufacture of plywood allows much value added to be gained. It is understandable, therefore, that producing countries continue to press for the reduction of these tariffs.

Table 4.4. Tariffs for plywood, blockboard, laminboard, battenboard and veneered panels, etc. except those of coniferous wood

Australia	Canada	EEC	Japan
m.f.n. 40%	m.f.n. 4%, 8%	m.f.n. 10%	plywood
40%+specific rate	GSP 3-7%	GSP (10%)	m.f.n. 15%,17%,20%
PNG 0%, 30%	m.f.n. 9.2%	ACP 0%	Other
30%+specific rate	GSP 5%	LDC 0%	m.f.n. 20%

New Zealand	Switzerland	U.S.A.
m.f.n. 20%, 35%	m.f.n. 5.4%-7.4%	m.f.n. 4%-8%
GSP 10%, 25%	GSP 0%	GSP partly 0%
NTM QR		

() GSP treatment limited by quotas or ceilings.

ACP = African Caribbean and Pacific (Ocean) countries associated within EEC under the Lomé Convention of least developed countries (LDC) have unrestricted duty-free entry to the EEC market for all the items listed.

PNC = Papua New Guinea.

QR = Quantitative imports restrictions.

NTM = Non-tariff measures.

[42/] Takeuchi, *op.cit.*, p. 74.

In spite of the three rounds of multilateral tariff negotiations, tariffs facing imports of wood products into the developed countries remain relatively high. For example, the average tariff on imports of secondary wood products in 11 selected developed country markets[43] was estimated to be 7.8 per cent (pre-Tokyo Round) and 5.7 per cent (post-Tokyo Round). In consequence, the trade effects from the hypothetical removal of tariffs would be very considerable; the developed market economy countries' imports of wood and wood products would increase by over US$ 950 million or 6.4 per cent of the 1976 value of imports[44].

Like the trade in most other product categories, the international trade in wood and wood products is regulated and controlled by means not only of tariffs but also of various non-tariff measures. For example, the volume-restraining measures (i.e. quotas and discretionary licensing) affect as many as almost 17 per cent of all wood and wood products groups. Second in frequency of incidence are automatic import authorizations which apply in the case of almost 15 per cent of product groups and third is total prohibition affecting 5.6 per cent of product groups. Other measures, not explicitly designed to control imports, are also very frequent. In particular, various standards (e.g. health, sanitary and technical) apply to as many as 87 per cent of wood products in Australia, 32 per cent in Japan, 19 per cent in Switzerland, and 13 per cent in France. These standards may have a particularly stifling effect on the growing export of wood chips and residues which the developing countries are accelerating in order to promote a higher utilization of their lesser-known species.

These measures have a dual negative influence on trade: they distort trade flows and they create uncertainty, thus impairing the formulation of export strategies (and, by implication, investment strategies); such strategies can indeed only be satisfactorily formulated in the light of a substantial degree of certainty concerning trading conditions. Indeed, it is

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43/ Australia, Austria, Canada, EEC, Finland, Japan, New ZEaland, Norway, Sweden and the USA.

44/ For details, see Tariff and Non-Tariff Measures in World Trade of Wood and Wood Products, prepared by UNCTAD for the World Wide Study, (UNIDO/IS 396).

not so much the level of tariffs and of other trade barriers that causes problems for trade but rather it is the fluctuations in levels, and the accompanying uncertainty about conditions facing exporters in different markets and at different times that create the real obstacles to an entrepreneur. Production and marketing adapt to the prevailing business conditions, including tariffs, etc., but as long as they start to fluctuate with high frequency, speculation rather than regular trade is invited.

4.4 Shipping and freight

Sea transport has been crucial to the world trade in wood and wood-products, and is the primary means of transporting timber and wood-products from producing to consuming countries, often over very long distances.

Transport in the wood trade has two elements:

a) internal transport (road, railway, river) from the forest areas and processing center, and

b) transport by ships from the ports to the consuming centers.

Looking at the tropical log trade, the main flows are as follows:

i) West and Central Africa to West Europe and to a lesser extent USA,

ii) South Asia and the Pacific to Japan, the Republic of Korea, the Chinese Province of Taiwan, Singapore and Hong Kong.

It is obvious that this pattern is influenced primarily by distance. Log exports from Southeast Asia to Europe are small compared to those originating from West Africa because of the high freight costs. It has been estimated that the freight element can be over 50 per cent of the fob value, on logs from East Africa to Europe, the Southern Mediterranean and the USA, while from Southeast Asia to Japan, the Chinese Province of Taiwan and the Republic of Korea it is about 20 per cent of the fob value.[45/]

Freight costs to Scandinavian ports are much higher than to Continental Europe and the U.K. because many shipping companies no longer ply to what were previously regarded as base ports in Scandinavia. This entails expensive reloading in Continental ports. The shipping opportunities from several ports of the world with large forest resources have further deteriorated because the ships have difficulties in finding cargo destined for these areas, thus increasing the cost in relation to payload. Obviously, these difficulties are exacerbated by import substitution policies which reduce the tonnage of imported goods and shift the burden of two-way shipping cost to the products exported, including forest products.

Turning to processed primary wood products, sawnwood freight costs are between 15 per cent and 35 per cent of the fob price depending on distance and certain other factors. Table 4.5 shows that they form between 16-35 per cent of the fob price from Southeast Asia to Europe, compared to 23-31 per cent from West Africa to Europe and 17-29 per cent from South America to Europe. The freight costs of plywood are about 20 per cent of the fob cost from Southeast Asia to Europe (Salgo, 1982) and 6-10 per cent of the total delivered cost of plywood in Japan (Takeuchi, 1982). These figures illustrate the importance of shipping in the cost of wood products, and would be higher if internal transport costs, insurance and port handling charges were to be included. It will be shown in the next section that the clear division of markets by product, particularly for Southeast Asian countries where the log trade is conducted with East Asian countries and the processed wood with Europe and USA, suits the needs of shipping; through not necessarily the exporting countries.

[45/] Peter Salgo, Shipping Problems in the Trade of Tropical Timber, UNIDO Discussion Paper, ID/WG.387/2, 1982.

Table 4.5. Approximate proportion of shipping costs of square edged lumber, 4th quarter 1982

	Per cent of FOB value
From the Far East to Europe	
Keruing	35
Ramin by liner	20
Ramin by charter	16
Dark red Meranti	18
Lauan	17
From West Africa to Europe	
Sapelli (entandophragma)	23
Iroko	31
South America to Europe	
Brazilian mahogany	17
Virola	20
Chilean softwood	94
Chilean softwood to Kuwait by charter	80
Papua New Guinea to Europe	
PNG Basswood kiln dried by container	28 1/2
Far East to USA	
Lauan to west coast	15
Lauan to east coast	21

Source: Peter Salgo "Shipping Problems in the Trade of Tropical Timber", UNIDO, ID/WG.387/2, 1982.

The relationship between distance and charges is loose. Dark red meranti on its long voyage from Malaysia to Europe with an fob value in the range of sapelli carries a proportion of about 16 per cent of freight whereas sapelli for the shorter distance from West Africa carries 23 per cent. The most important factors influencing freight costs are:

- the distance between the exporting country and importing country,
- the load which combines the factors quantity, weight (degree of processing) and "bulkiness" in the stowage factor,

- the packaging methods, (bundling)
- the port handling facilities,
- maritime insurance rates,
- the frequency of the shipping services,
- the capacity of the vessel,
- restrictions limiting the draught of ocean-going vessels that can be accomodated,
- competitive factors.

Each one of these factors can influence the cost of shipping, some more than others, but when combined there can be large differences in the costs of transportation from different ports for the same commodity. Many shipping lines and conferences quote preferential rates based on size and the quality of the bundling. In some countries, standards in this respect have not yet been developed; the present system in use in West Africa might constitute an efficient starting point for developing internationally accepted standards.

To achieve significant savings in present transport costs for further processed wood, greater use of containers must be made. Shipping in containers reduces the costs associated with damage while in transit, with transshipment, and with insurance. To this end, shipping ports must be able to handle containers. Presently, this is not the case in many ports used to ship tropical wood products.

Shipping of tropical wood products may be divided by the nature of the service and technical features of the vessels as follows:

a) Conference and non-conference liner services with conventional and sophisticated vessels sailing regularly on a published schedule between specified ports, and

b) Chartered bottoms with prior agreement on the route, ports of call and timing for the loading operation to start. The minimum loading and unloading rates and involvement of the ship in these operations are also specified.

The basic difference between the two is that the nature of service and the price of chartered services are negotiated between the shipowners and users whereas liner services, particularly if members of a conference have pre-determined freight rates with varying surcharges and discounts depending upon custom and circumstances at the time. There are six lines that call regularly from East Asia to West Europe with some independents calling from time to time. Each of these lines issue their own freight rate schedules, which can vary by about 10 per cent, but at the same time could be negotiated, especially during lean times. In East Asia, in particular, there is considerable competition in shipping, unlike in West Africa, and most of the lines are outside the Conferences. Price under-cutting is common. Conference lines, which are thought to charge what the traffic would bear, tend to practice price discrimination, lowering prices where they face competition from independents, while maintaining high charges where there is little competition. In the latter areas, many developing countries find that the existing patterns of transporting timber are obstacles to export growth. Predetermined shipping routes make the development of new markets difficult and differential freight rate policies reduce the additional value added that could be achived through further processing of raw materials.[46]

Chartering is an alternative, and there are two main methods:

i) a vessel is chartered for one specific voyage, starting within a specified period, for a lump sum where there is an agreed rate for loading and unloading;

ii) a time charter which is similar in character to (i) above, but which allows free movement of the ship during a given period of time. (In effect giving the charterer rights to act as shipowner for the given period).

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[46] Commonwealth Secretariat, "Cooperation for Accelarating Industrialization", Final report by a Commonwealth Team of Industrial Specialists, London, 1978.

Important factors in chartering are the load, and the capacity of the vessel. A common problem in shipping in developing countries is the inability of the charterer to have enough cargo to fill the ship, thus not getting the full cost advantages of chartering. Often individual exporters or shippers make their own arrangement for space in liners which are willing to accept smaller volumes to fill the ship during lean times or whenever it is convenient in their schedules. In such circumstances, there could be drastic variations in freight costs from one shipload to the next for the same destination depending on each arrangement. One suggestion has been for timber shippers to set up a freight booking centre within a country or region, whereby long-term contracts for bulk shipments can be negotiated with a few reliable operators who can offer cheaper contractual freight rates on a year to year basis.[47/] Long terms contracts guaranteeing operators full shiploads of bundled timber, would encourage purpose-built timber carriers. With cargo space designed for maximum space use, there could be freight savings of over 50 per cent.[48/]

The combination of the above factors together with often inadequate and congested port facilities result in generally high and often unpredictable transportation costs affecting the ability of many developing countries to benefit fully from trade in wood products.

It is important for exporting countries to assess their shipping requirements for the timber products and the principal trade routes or markets to determine:

i) the quality of port services and handling methods that will reduce costs;

47/ Leslie Eu, "The Economics of Shipping Timber in Bulk", paper presented at the 2nd Malaysian National Timber Congres, March 1979, Kuala Lumpur.

48/ Danko Kolydrovic, Avenues for a more efficient sea transport system for timber products, 1st Malaysian National Timber Congress, November 1976, Kuala Lumpur.

ii) the optimum shipping system for timber products with and without consolidation of shipments with other compatible commodities;

iii) the optimal size and type of vessels; and,

iv) the total costs of transportation including freight rates.

4.5 International prices of wood and wood products

An analysis of prices of commodities over time is difficult and imprecise because of qualitative differences over time and across grades and species. In addition, the existence of long term contracts and fluctuations in exchange rates can both hide and exaggerate true market price movements. Nonetheless, some long term trends in the relevant prices can be observed.

Figures 4.1, 4.2 and 4.3 show real price trends for selected products from 1961 through 1979. In general, the prices of logs and sawnwood have risen over this period while the price of plywood, fibreboard and particle board have fallen. The most pronounced decrease over the period was in the price of particle board. These trends are consistent with two well known facts about the wood sector: (i) timber supplies are becoming more scarce and (ii) productivity gains in the more highly processed products have more than offset the increased costs of raw materials. While data for the years since 1979 will show price declines for these commodities, this long term trend is probably still valid.

These figures also show that short term price fluctuations are strongly correlated with general business conditions. The main wood consuming sectors (viz. construction and durable goods) are among those sectors most strongly affected by cyclical business patterns.

On the demand side, the income elasticity is relatively high, and the price elasticity relatively low, particularly for decorative tropical wood.[49] The price elasticity of utility hardwood timbers suitable for furniture and joinery framing is slightly higher due to their easier substitutability by coniferous species and other non-wood commodities. The price elasticity of demand for unprocessed tropical wood (sawlogs) is lower than for processed tropical timber (sawnwood and plywood) because of long run supply contracts and because value added through further processing in consuming countries means that the price of the raw material becomes relatively less important.

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[49] See also O.P. Hansom, UNIDO.ID/WG.387/3, 1982, op. cit., pp. 18-21 and Raj Kumar, "A Quantitative Analysis of the Elasticities of Export and Home Demand of Key Malaysian Wood Products", Kajian Ekonomi Malaysia, Vol. XVII, No. 1, 1981.

On the supply side, the price elasticity is low, particularly for sawlogs due to the largely unplanned nature of most tropical forests. The growing scarcity of such supplies accounts for the rising trend in real prices of sawlogs, a trend that can be expected to continue. This is also evident in a comparison of price indices between forest products and other commodities (see Table 4.6.).

Table 4.6. World export price indexes of wood products compared with selected commodities, 1975=100

Commodities	1950	1960	1970	1980
Forest products[a/]	...	...	49	191
Sawlogs	...	...	57	313
Sawnwood	34	36	51	169
Woodpulp	30	35	41	122
Natural rubber	90	91	46	253
Coal	19	21	32	127
Crude petroleum	15	16	15	295
Copper	41	55	114	177
Aluminium	37	64	71	205
Tin	30	32	54	246

Source: United Nations Statistical Yearbook, New York, 1979/80.

a/ Includes all wood products on an aggregate basis.

Insofar as the tropical non-coniferous wood products are concerned, current levels of prices do not take into consideration the actual cost of the replacement of the material resources. The concept of prices being "remunerative to producers and equitable to consumers", which has become established in the UNCTAD negotiations under its Integrated Programme for Commodities, holds for tropical wood and wood products a deeper significance than it does for other commodities or manufactured products. This significance rests on the fact that the tropical forests are being mined like minerals and that, given the present rate of depletion, the resources will dwindle at such a rate that the current exploitation policies are not viable in the longer term.

The continuous supply of industrial logs in terms of both quality and volume is fundamental to the increased and diversified wood processing in the countries where the forests are situated, as well as to those importing countries in the developed world who depend upon this vital raw material. The question of prices is interlinked with the forest replacement costs, directly or indirectly, and present indications are that what cannot be obtained in the market place is being or will be obtained through executive initiatives such as export volume control, or export bans.

CHAPTER 5. Some policy related issues concerning the development of wood processing in developing countries

5.1 The role of the wood industry in the industrialization process

The analysis of the preceding chapters has shown that this sector can play a significant role in the development and industrialization of a developing country. It acts as a major purchaser of domestic raw material thus providing both employment and income. It also purchases services from other sectors, primarily the capital goods sector, the transportation and the service industries. Many of these suppliers can be, and are, domestic enterprises of varying size and sophistication. Thus, the sector can act as an engine of growth and can facilitate the creation of technical tradition. This is especially the case in the relatively simple operations of the primary and secondary mechanical processing industries. In many countries the sector is a major source of foreign exchange.

A further important aspect is that the wood sector, especially primary processing, promotes rural development which is a social goal in some countries.

As part of a resource based industrialization strategy, the processing of forest resources into products of higher value added content is a possibility for many developing countries with large areas of forests (cf Chapter 1). Generally it will be advantageous to develop a mix of integrated industries to utilize more fully the diversity of material available from their forests. Pulp, fibreboard, particle board, chemical products and fuel are the products which can use a wide range of wood materials.

The manufacture of pulp is a very capital intensive, advanced technology process, usually making even the smallest economic sized pulp mill a large undertaking, particularly when compared to a sawmill or plywood plant. Particle board as well as fibreboard is produced primarily for domestic consumption and notably the developing countries have, in part for climatic reasons, thus far not been significant consumers of these boards. Also, particle and fibreboards are seldom exported overseas because of their low value-to-shipping cost. Therefore, this option, as a rule necessitates a creation of domestic markets for these products, and overcoming the problems associated with high humidity. Fuelwood is perhaps the most common forest product in the developing countries. About 80 per cent of the wood harvested from tropical forests is used as fuel. Fuel could, of course, be produced in forms with higher calorific value than solid wood, for instance, charcoal and methanol.

What then are the opportunities to develop a more sophisticated mechanical processing wood sector that can encourage a rational long term development strategy and generate the long term investment that would be required? The greatest possibilities are in the development of domestic markets for mechanically processed wood, notably local housing and commercial buildings. Many tropical countries have large populations that are at times poorly housed and this constitutes a potentially great market for sawnwood and plywood. Experiments to develop unused or underutilized local species for housing applications could be undertaken on local markets in a way which would not be feasible on export markets. Following successful development of the local and regional markets and increased consumption of mechanically processed wood, attempts could be made to penetrate the export market.

5.2 Advantages of a resource based industrialization

In 1980, over 91 per cent of the non-coniferous sawlog and veneer log exports came from developing countries compared to 65 per cent for non-coniferous sawnwood and 32 per cent for wood based panels. This large difference between processed wood and unprocessed wood in the exports of the developing countries underscores the argument that there could be greater domestic processing of the raw material they export. The case is reinforced as world figures of imports by developing countries for the same year were 33 per cent of world imports for sawnwood and 15 per cent for panel products, in part coming from the raw material they exported. In total the developing countries imported about $8.5 billion of forest products in 1980; total exports were $8.7 billion; of these, $4.6 billion and $1.1 billion were pulp and paper products, respectively.

The export of logs has been predominant because it requires less domestic infrastructure, capital, and skilled manpower than domestic processing, and it provides quick and ready revenue in the form of royalties, duties and taxes as well as foreign exchange. This has been the situation in most developing countries thus favouring exporters at least in the short run. In addition, the difficulty of entering the markets for processed forms in importing developed countries and the lack of demand in the exporting countries themselves has kept local processing of tropical logs low. These causes are gradually disappearing and domestic processing in the log-exporting countries is becoming more attractive.

A call for a deliberate policy of encouraging domestic processing of logs where it is not being carried out or is still in its infancy has been launched by developing countries. Those countries that have made headway in some form of primary processing are asking for its expansion as well as increasing the impact of secondary processing on their economies.

The industrialization process is speeding up. Growth in the manufacturing value added of wood and wood products between 1973 and 1979 was 5.7 per cent in developing countries compared to less than one per cent for developed countries. However, the share of the world manufacturing value added for developing countries stood at only 11 per cent in 1980 compared to 65 per cent for developed countries and 24 per cent for centrally planned economies[50/]. In 1970, the corresponding figures were 9, 73 and 17 per cent, respectively.

The arguments for a resource based industrialization can be summarized as follows:

(i) Increase in value added and economic development

Table 5.1 shows the estimated value added to logs by processing in Malaysia, Indonesia and the Philippines. Gross value added to logs is the difference between the f.o.b. export value per m^3 for logs and the f.o.b. export value for the corresponding amount of each product which is produced from one m^3 of log input. This is shown to be from -1 up to 66 per cent

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[50/] See UNIDO/IS.368, A Statistical Review of the World Industrial Situation, 1982, op. cit.

greater than log export unit value for sawnwood and 17 to 151 per cent for plywood. The reasons for the negative figures shown for veneer sheet are not immediately obvious but may have to do with data limitations which combine decorative and plywood veneer and thus do not present a valid picture. In general, one must not place too much emphasis on these figures since there are limitations in this approach as it does not quantify taxes, foreign exchange outflows and linkage effects in terms of the value added to other industries providing materials to the processing industry. Nevertheless, it demonstrates that the value added could be positive or negative under different circumstances. The level of value added tends to be positive but how much will depend on the quality of the wood resource, the processing technology, managerial quality, productivity of complementary inputs, relative factor costs and, of course, the ability to sell the product.

Table 5.1. Estimated gross value added to logs by processing in Indonesia, Malaysia and the Philippines, 1977 and 1979

(US$ per m^3 of log input and as per cent of log value per m^3)

Country and product	1977		1979	
	$\$/m^3(r)$	Percent	$\$/m^3(r)$	Percent
Indonesia				
Sawnwood	(-) 1	(-) 1	24	31
Plywood	39	83	47	62
Veneer sheets	...	...	...	...
Malaysia				
Sawnwood	25	66	27	62
Plywood	58	151	60	140
Veneer sheets	(-) 9	(-) 22	(-) 17	(-) 40
Philippines				
Sawnwood	15	23	4	3
Plywood	17	26	20	17
Veneer sheets	3	5	(-) 15	(-) 13

Source: Adapted from Kenji Takeuchi, "Mechanical Processing of Tropical Hardwood in Developing Countries: Issues and Prospects of Plywood Industry Development in the Asia-Pacific Region", World Bank Division Working Paper No. 1982-1, January 1982, p. 76; original data: FAO 1980 Yearbook of Forest Products.

Note: Recovery rates are 55 per cent, 50 per cent and 52.5 per cent for, respectively, sawnwood, plywood, and veneer, as assumed in Takeuchi; *op. cit.*, p.76.

(ii) Increased resource utilization

Presently, a large proportion of the wood raw material is left in the forest because it cannot be exported. Increasing the domestic processing, which can utilize these non-exportable resources, therefore implies a higher resource utilization.

(iii) Employment creation and increasing skill levels

Relative to the development of other resources such as oil and minerals, wood processing is labour intensive, and therefore has potential for increasing employment, particularly in rural areas. At the same time, it gives the opportunity for building up skills and professionalism not only in the sector itself but in other industries that are linked to the sector such as equipment maintenance and engineering. Kumar (1982) shows that the employment elasticities of 0.7 and 0.3 for Peninsular Malaysian sawmilling industries between 1960 and 1976 have resulted from changes in exports and home demand, respectively. For plywood the corrresponding figures were 0.9 and 0.71. From 5 to 14 persons are required to produce 1,000 m^3 of plywood compared to 3 to 6 persons for the same amount of sawnwood. The high and low ends of the two ranges reflect the situation in the developed and developing countries, respectively.

(iv) Balance of payment effect

Foreign exchange benefits are realized when the processed wood is exported and when the retained value, i.e. the difference between all foreign exchange inflows and outflows arising out of the processing activity, is positive. There are also foreign exchange savings when processing substitute imports, provided the value of the inputs imported to process raw material does not exceed these savings. Moreover, import substitution reduces national dependence on the potential vagaries of external supply.

Most developing countries are net importers of energy. The wood and wood processing sector has a high potential in certain areas for energy self-sufficiency. Therefore, an industrialization strategy that stresses this sector will affect the balance of payments situation in a much more favourable way than sectors which are heavily dependent on imported oil or other forms of energy.

(v) Lowered freight costs

Producing sawnwood and plywood reduces the weight and volume of the raw material by 40 and 60 per cent, respectively. At the same time, however, freight rates increase, thereby reducing the net economic effect of the weight and volume reduction.

(vi) Distribution effects

Processing facilities are likely to be concentrated in the remote areas which has an industrializing effect on these regions where other opportunities are scarce. In this sense wood based industrialization can assist in improving the income distribution among regions, and in promoting political and social stability. Such a case is being made for Sabah in Malaysia, Kalimantan in Indonesia and Mindanao in the Philippines, where there are deliberate policies to subsidize wood processing to promote regional development.

The extent to which the above benefits will be realized depends on the stage of development of the country concerned and the efficiency and cost-effectiveness of the industry. The latter depends on infrastructure including transport and appropriate financial services.

5.3 Essentials for mechanical wood processing including finance and investment incentives

The following conditions will contribute greatly to successful domestic processing of logs:

(a) the availability of capital and manpower at the given location to set up a processing industry;

(b) the assurance of a continous supply of raw material over the long run;

(c) the existence of markets for processed wood, both domestic, regional, and export;

(d) the existence of complementary industries that can make use of the considerable amount of waste in logging, sawing and primary processing; and

(e) the possibility of using lower quality wood in the domestic industries.

It is true that leading wood processing countries such as Republic of Korea, the Chinese Province of Taiwan and Singapore have built up efficient facilities without the benefit of domestic raw material supplies. But it is going to be difficult in the future to depend on external sources for logs. Wood producing countries therefore have to give high priority to reforestation to ensure cheap and continuous supplies of the raw material to attract investment in processing.

The existence of domestic markets is very important in order to promote stability on the demand side and reduce reliance on exports which are more subject to external factors beyond the control of the industry or the country in question. While exports can be an important source of revenue, the market is quality conscious, highly competitive, and unstable. In the first phase, it is useful to gear processing to meet domestic needs. The role of secondary processing, particularly in producing wood products that suit domestic needs, assumes a special importance.

The developmental effects of establishing a wood processing industry will also depend, i.a. on the following factors:

(a) Choice of techniques

Whether production techniques should be labour or capital intensive depends on the requirements of the products themselves as well as on the availability of skills at all levels in the country. Table 3.4 above has summarized the technological considerations for the production of wood based panels. It can be seen that basic infrastructure in terms of transport and other services is important in developing an efficient wood processing base.

Also important are the level of training of supervisors, managers and technical support staff as well as an atmosphere for innovation in product design and engineering which can meet market specifications. Similar tables could be developed for other wood products as well.

Characteristic of the wood processing sector is that a wide range of appropriate technologies and levels of mechanization exists for various external conditions. Which technology and which level of mechanization to choose in a particular situation is a tricky task and certainly not best left to equipment salesmen. It would be a suitable task for the international organizations to assist in the choice and adaptation of technology for specific projects. In general it can be said only that the technology and level of mechanization must be appropriate to the type and scale of production, the amount and characteristics of the local endowments, the availability of infrastructure, capital, labour and management skills, and to maintenance possibilities. These aspects are dealt with in more detail in section 3.9 above.

(b) Finance

There is a close link between the nature of a project and the type of financing. If the wood processing project is purely a commercial proposition, its ability to attract finance will depend on the profitability of the project. The greater the expected risk-adjusted rate of return, the more attractive the project. For a commercially oriented project, the objective is to make it attractive to private investment and commercial financing.

However, if the wood processing project has a "social" dimension, in the sense that it might be commercially marginal but socially desirable, there is scope for concessionary financing through loans and grants from development-oriented financial institutions or bilateral aid agencies. Both loans and grants may be tied, partially tied, or untied, particularly in the case of bilateral assistance.

Another interesting feature is co-financing, e.g. between commercial banks and development institutions. Co-financing is being increasingly used particularly for large projects. One of its strong points is that it distributes the risks of the project. Commercial interests may be attracted to the project if there is some form of concessionary financing from international institutions as this arrangement can reduce their risk perception.

There has been a change in emphasis in the World Bank's lending policy to the forestry related sector since 1978. It has shifted its interest from economic growth oriented industrial forestry projects, such as integrated pulp and paper mills, to rural forestry programmes involving small farmers while taking into account forestry's environmentally protective role. The Asian Development Bank and Inter-American Development Bank are following suit. In 1978, the OPEC Fund expanded the sphere of its concessional lending activities to include forestry and forestry related industries. The first loan of this kind was granted to Nepal for the benefit of the "Sagarnath Forestry Development Project", which is undertaking the reforestation of 10,000 ha of the central region of Nepal with fast growing tree species. Of course, these institutions also consider loans for establishing industries which favour the integrated optimal use of forests.

Clearly, there is scope for greater co-operation in wood processing among private investors, donor agencies and tropical producing countries. For this purpose, it is necessary specifically to determine industrial wood production financing needs for developing countries, which are separate from those related to forest management and reforestation. Financing wood processing projects is relatively easier from commercial sources than, say, reforestation projects or multiple-use projects which, due to the long-term nature of the investment, require concessionary financing that gives longer periods of loan amortization and grace.

(c) Investment Incentives

If private investment is desired, the fiscal regime and investment incentives should be skillfully designed so as to allow fast payback for the investor, especially in a risky venture, while at the same time ensuring that the government gains the maximum benefit from a situation of high profitability. Detailed consideration of the fiscal regime is beyond the scope of this paper, but table 5.2 summarizes some of the incentives being given to promote domestic processing reforestation and private investment in selected countries.

To promote domestic processing, government policies have included:

(i) quantitative controls on the export of wood in the unprocessed form;

(ii) heavier export duties on unprocessed wood than processed wood;

(iii) lower royalties on timber that is processed domestically;

(iv) various tax allowances, including tax holidays, accelerated depreciation, duty free import of equipment and exemption from dividend withholding taxes for firms establishing new wood transformation industries, all enabling the investor to achieve faster payback of his investment; and

(v) introduction of specific provisions for wood processing in timber concession agreements.

Determining the success of these incentives requires a thorough evaluation. However, the increase in the flow of processed wood products from Malaysia, the Philippines and Indonesia in recent years does support the notion that the above measures have had an impact, although it has to be stressed that many are of recent origin and have not yet have exerted their full impact.

Tax and other incentives should be given on a case by case basis and should be aimed at lowering the supply price of investment either through reducing risk or making marginal projects commercially more attractive. The supply price of investment may be defined as the minimum rate of return the investor expects on his capital. This rate includes his perceptions of the risks and uncertainty, including political risks. Incentives should be selective and backed by contractual agreement to process wood, reforest and reinvest. They should be subject to periodical review and further, since incentives are administively cumbersome, they should usually not continue indefinitely. An industrial environment conducive to long-term investment and stability of contract conditions are more important in determining the decisions to invest than a series of incentives that may produce small savings.

Table 5.2. Incentives for domestic processing in reforestation and private investment in tropical wood producing countries

	INCENTIVES		
	Domestic Processing	Reforestation	Private Investment
MALAYSIA	(a) Ban on export of selected species of unprocessed logs as well as annual quotas. (b) Removal of an import duty of 15% ad-valorem and a surtax of 5% on log imports. (c) Various locational incentive schemes provided for a number of areas so as to encourage domestic production of sawnwood and forestry projects (d) In Sarawak, 30 % of the annual cut is permitted to be exported during the first 5-year build-up of large scale processing facility so as to produce revenue to ease the initial heavy burden of capital outlay.	(a) New large concession agreements tied to reforestation commitments with state government reimbursing the whole or in part for silvicultural expenses incurred in operations of concession area. (b) Expenditure incurred on the clearing of land, new planting and road construction can be written off over two years while plant and machinery used in reforestation qualifies for an initial depreciation allowance of 60%. (c) Nearly 200,000 hectares are being planted on 15-20 year rotation between 1981-85 to compensate the supply of logs for domestic use only by 1995.	(a) Various investment allowances, including locational incentives, reinvestment allowances, accelerated depreciation, promotional expenses. (b) New Forest Industry Development Policy which encourages relocation and modernization of existing wood-based industry, the setting up of integrated timber manufacturing complexes and use of all forms of forest and mill residues and lesser known species.

Table 5.2. (Cont'd)

	INCENTIVES		
	Domestic Processing	Reforestation	Private Investment
INDONESIA	(a) Since 1978, a 20% export tax on logs, increased from 10% (1971-1977). For semi-processed timber it is 5% and all other timber exports, 0%. (b) Inclusion of processing clauses in timber concession contracts, requiring investments in saw mills, plywood plants, and wood-chip operations after a specified period. (c) Restrictions on the share of exports that may be shipped in the form of logs. Since April 1980, all forestry licence holders who have held licences for more than 7 years (the great majority of firms) may export only 40% of production in the form of logs; the remaining 60% must be sold to local processors or be transformed into processed products by the timber exporter himself. (d) Log export taxes not collected on primary and secondary wood product exports. (e) Exemptions and reductions in import duties on machinery and equipment and accelerated depreciation. (f) Carrying forward of losses during 4 successive years; losses occurring during first 6 years or over can be carried forward.	(a) Need for a US$ 4 per cubic metre replanting of deposit on all exported logs. This is refundable when investor produces evidence of adequate replanting.	(a) Foreign private investment allowed up to 85-100% participation. (b) Profit repatriation guaranteed.

Table 5.2 (Cont'd)

INCENTIVES

	Domestic Processing	Reforestation	Private Investment
PAPUA NEW GUINEA	(a) A 50% rebate of the export tax on logs (or 10% f.o.b. value) subject to satisfactory performance in accordance with a defined land negotiated processing schedule. (b) New reforestation projects will be linked to processing after the end of century. (c) Enterprises which have agreed to process within PNG will not generally be required to undertake reforestation. (d) Foreign enterprises that process at least 30% of total log harvest may, at the discretion of Government, undertake projects which export logs.	(a) Essentially a National Government's responsibility and objective is "to establish a limited number of large economically viable reforestation projects at carefully selected sites." (b) Foreign enterprises may contract to carry out large scale reforestation in return for the right to export logs. Ownership of the reforested area will vest in the National and/or Provincial governments and/or the customary landowners, according to the terms negotiated.	(a) Export incentive scheme that reduces income tax on projects related to the growth of export sales of selected wood processing industries. (b) Accelerated depreciation allowances.

Table 5.2.(Cont'd)

INCENTIVES

	Domestic Processing	Reforestation	Private Investment
FIJI	(a) Removal of customs duties on suitable processing equipment for sawmills, veneer mills, drying kilns, skidders and trucks.	(a) Mainly a government responsibility done jointly by the Forestry Department and the Fiji Pine Commission, a statutory body. (b) Forestry Department encourages private planting by individuals, communities on their own land unsuitable for agriculture by giving subsidies in the form of reduced cost of seedlings, free transportation and free advice, (the so-called Extension Scheme).	(a) Tax incentives. (b) Accelerated depreciation. (c) Export incentives.

Source: Raj Kumar, "Fiscal Issues and Investment Incentives in Tropical Forestry", Technical Assistance Group, Commonwealth Secretariat, London, 1983.

5.4 Policy issues in integration

A survey of a large number of forest policies in developing countries highlights vertical integration of the wood processing sector as a desired goal. The aim is to increase productivity through maximizing wood recovery. The lack of domestic markets and facilities to make full use of mill residues (off-cuts, slabs, edgings, wood chips, saw and sander dust) in developing producer countries has been cited as a case for processing the raw material in developed countries where both facilities and markets exist to make use of these residues for manufacturing other wood products, such as fibreboard, particle board and pulp.

The integrated operation is initially looked upon as comprising logging, sawmilling and veneer and plywood, and is geared towards maximum use of the forest resources. This is not enough. The next stage of integration would include fibreboard, particle and block board, packing cases, furniture components, and even pulp and paper production facilities to make full use of the residues and wastes arising from logging, sawing and veneer making activities.

Technically and economically speaking, there are advantages in integration. A suitable starting point for integration would be the greater utilization of wood residues (branches, bark, tree tops, sawmill waste, etc.) for panel production and energy generation for the plant itself and for the power grid. For panel production, well established technologies even for small-scale production exist and are suitable for tropical woods. Further successful integration into secondary processing should be contingent on the existence of, or the potential for, complementary industries or consumer markets.

On the other hand, complexes with horizontally integrated operations existing in developed countries and attempted in some developing countres are capital intensive. A logging-sawmilling-wood panel production complex needs an investment of about US$ 10-30 million[51], and if a pulp and paper unit were to be included, more than US$ 100 million in current prices. The costs will vary according to the location of the plant, the state of technological development and the physical infrastructure, the availability of replacement parts and service. A large-scale in-plant integrated operation calls for setting up supporting services such as housing and health, more sophisticated engineering and maintenance facilities, technical training and research. Such operations represent an advanced stage of industrialization that need careful planning and construction. However, small-scale integrated operations exist in China and other developing countries. Their suitability in different socio-economic settings would need to be evaluated, and if found useful for the developing countries in general, promoted through technical and economic assistance programmes.

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[51] Takeuchi, _op. cit._

5.5 Pulpwood in tropical countries

A recent development in the tropics has been experiments with quick-growing species for pulp production. This has been mainly done by government agencies with assistance from FAO and the World Bank and is usually based on ensuring continuity of supplies. Most areas include a softwood species component (often Pinus caribaea) and a fast-growing hardwood tree (Eucalyptus deglupta and/or Gmelina arborea). These projects are still in an experimental stage; their success is not yet fully assured but will hinge on technological developments that facilitate processing mixed tropical species with different densities and varied geographical distribution on a cost-effective basis. If this is feasible, we can expect large areas in tropical countries to be devoted to producing trees for pulp to meet domestic and even export requirements.[52]

If these experiments are successful, would tropical wood compete with the sources of pulp from temperate countries? The potential is there at least for short fibre demand if competitive in terms of price. The advantages are that growth is rapid (7-25 years) and labour is cheap. If done on a large scale there is immense potential for tropical countries to compete with traditional pulpwood suppliers. To some extent, Brazil has shown that this can be done. Until the end of the century, however, competition in the pulp market from tropical species will be slight since the area devoted to such ventures is small. But if progress is made on the technological side, tropical species will be a competitive source of supplies during the 21st century, although there are technical limits to the amount of short fibre than can be used. In the USA, about one-third of all pulpwood now comes from non-coniferous species and in Japan about one-half. However, this is a result of hardwood timber prices being lower than those of coniferous species for both short and long fibre.

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[52] For a discussion, see K.F.S. King, 'The political economy of pulp and paper' Unasylva, Vol. 29, No. 117, 1980, pp.2-8; and S.L. Pringle, 'The future availability of wood pulp: a world picture', Unasylva, Vol. 29, No. 116, 1980, pp. 18-25. See also N.A. Burdin and V.A. Sylantyev, op. cit.

Tropical countries such as Cameroon, the Philippines and Brazil have set up their own pulp and paper industries as a means of obtaining foreign exchange and providing employment. Export possibilities are also considered. But capital demands for such projects are high, and in smaller countries progress is likely to be slow due to input constraints and the small size of the domestic market.

Until recently, there has not been much chemical wood processing in the developing countries. This is largely due to technological reasons, capital intensity, the characteristics of tropical woods, and available skills. The limitations imposed by small markets and little available capital have also prevented the achievement of scale economies available to the producers in the industrial countries.

5.6 Relocation of wood processing from developed to developing countries

The question of relocating existing facilities to developing countries goes hand in hand with the development of new wood processing. There are two aspects to this argument:

(a) Wood industrialization as part of a larger effort to promote economic growth in developing countries, thereby ensuring continued prosperity in the developed countries through strong interdependence between developed and developing countries;

(b) Factors that increase the competitiveness of wood processing by relocating in developing countries.

Long term economic growth in industrialized countries is strengthened if the developing country economies are strengthened. It is claimed to be in the long term interest of developed consumer countries if relatively less sophisticated forms of industrial processing of wood are relocated in developing countries that supply the raw material. While economic criteria are important, consideration should also be given to political, strategic and other non-economic factors, meaning that some trade-offs between purely economic considerations and other objectives are necessary.

Turning to (b), developing countries have a comparative advantage in wood processing (cf. section 3.1). These include:

(i) reduction in transport cost;

(ii) lower labour costs;

(iii) sometimes availability of cheap energy supplies (this has particular relevance for fibreboard production); and

(iv) assured raw material supplies at lower cost.

The inherent advantages are that converting logs to sawnwood and plywood can reduce by 40-60 per cent the volume and weight of the raw material; this leads to lower freight costs which can account for up to 50 per cent of the delivered price of tropical timber in overseas markets. The distances between the exporting and importing countries are usually large, and even where small, for instance between Japan and Southeast Asia, shipping costs can be between 15 and 25 per cent of the f.o.b. price of sawlogs. This leaves quite a wide margin to take into account the productivity differentials, which in any case will narrow over time once the industry has been firmly established in the developing countries. Takeuchi's (1982) study of ocean transport cost between Japan and Sabah and Kalimantan showed that a transport saving of $5-12 at 1980 prices can be realized, *ceteris paribus*, if plywood was manufactured in the developing regions for Japan.

The 1982 Yearbook of the Labour Statistics of International Labour Organization (ILO) shows net wages in wood producing Asian countries were about 1/30 to 1/5 of the wages levels in Japan and 1/18 to 1/11 of those in Republic of Korea. Even if productivity differentials are taken into account, there will still be large savings in labour costs by shifting processing from the importing to the exporting countries.

The large amounts of electric power available, or potentially available, in some developing countries such as Uganda and Zimbabwe at rates lower than in industrialized regions can be an important cost saving items. Energy cost in Malaysia, Indonesia, Ghana and Nigeria are relatively low. Especially kiln drying in the primary wood processing industries consumes large amounts of energy. The energy requirements for hardwood are larger than for softwood. For drying, the tropical sun in the wood producing countries might be able to assist in reducing energy costs which arise from artificial drying. Wood residues at plants in the log exporting countries can be economically used for fuel.

In a world of scarce industrial raw material supplies, guaranteed raw material supplies is becoming an advantage. Most new concession agreements insist upon wood processing in the producing countries as a condition for logging. It therefore makes good economic sense for the investor to give guarantees of local processing in return for the use of wood supplies. When combined with reforestation obligations, the investor can manage and control supplies for the processing plants. In order to encourage domestic processing, developing countries should give guarantees of stable and long-term raw material supply contracts in return for domestic processing and reforestation guarantees.

Among the disadvantages to relocation claimed by producers in developed countries are the existence of processing installations in the industrialized countries, the existence of scale economies that may not be achievable in export oriented operations or in the small markets of the developing countries, and lack of infrastructural facilities including local management and skilled labour. Moreover, the tariff structure in industrialized importing countries is frequently biased against processing in the developing countries. There are also perceived 'political risks' in that a host government might increase taxation, restrict the firm's freedom to buy inputs to or to sell its products wherever it wants by demanding that the wood be sold for the local processing industry, nationalize without adequate compensation or otherwise fail to honour the agreements reached. Finally, a firm's unfamiliarity with the social and economic environment of the developing country will be viewed as a risk or cost element. However, many of the perceived disadvantages may be more imagined than real; nonetheless, as long as they are considered as such, they will adversely affect relocation decisions. Thus, there is a need to quantify objectively the various factors contributing to comparative advantage and present them in terms of strategy packages, taking into account the viewpoint of all concerned parties: the raw material supplying country, the multinational or other investor, and the importing countries.

The above comparisons are made in static terms. Over time, some of the short-term disadvantages such as costs of relocating and of closing down plants at home, poorer infrastructural facilities in developing countries and political and other risks, real or imagined, will gradually diminish. Likewise, the tariff barrier issue will appear a mere transient problem that can be negotiated and resolved more quickly given the convergence of interests.

It has to be stressed that relocation is not going to be an easy task. To make any headway, there is a need for a quantification of the economics of the exercise. The success will depend on close collaboration among the suppliers of raw materials, the industrialists and the consumers.

Recent development in South East Asia can serve as an example of development towards greater processing in the log producing countries and restructuring of the wood industry in the region.[53/] First this involved

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53/ A special study has been made by UNIDO's Division for Industrial Studies comprising contributions by Fukasaku K.: "Structural change, adjustment problems and policies related to the wood processing industry in Japan", UNIDO/IS, 1983 (forthcoming) and H.P. Brion: "Potentials and requirements of increasing the degree of wood processing in developing countries of Asia and the Pacific", UNIDO/IS.395, 1983, as well as a concluding document which will be issued later in 1983.

substitution of exports from Japan. This was followed by increased restrictions on log exports imposed by some of the major producing countries, and the emergence of the developing countries in the region as efficient suppliers of processed wood products.

The extent and direction which this restructuring will ultimately follow are as yet uncertain. One alternative will be a gradual shift in the production of primary wood products towards the developing countries; there will be a trend towards more secondary processing in the newly industrialized countries and a continued gradual shift away from primary production in Japan. Another alternative would involve continuing protection of primary production in Japan and a gradual shift away from South Sea hardwood logs to the processing of softwoods from alternative sources. Thus far this restructuring of the regional wood products economy has proceeded along the lines of the first alternative.

The following activities and policies could further the interests of the developing countries in the region to increase their degree of wood processiong that involve co-operation with Japan.

(i) Actions which tend to strengthen the role of developing countries in supplying products from the secondary sector to the Japanese market. At present only a small portion of Japanese imports in this sector comes from the Asian developing countries, with the exception of the Republic of Korea, Chinese Province of Taiwan, Hong-Kong and Singapore which together account for some 60 per cent of total Japanese imports of wood furniture and parts;[54/]

(ii) Joint ventures with Japan, which have provided some technical assistance, have been undertaken to a limited degree and have usually proved successful. These types of projects should be expanded;

[54/] Furnitures Export and Imports of Japan, 1977-1981, International Development Association of the Furniture Industry of Japan, Tokyo.

(iii) While future exports of plywood and sawnwood to Japan may be possible, it is unlikely that the Japanese market will have much potential for these products as long as there exists such a large over capacity in the Japanese primary products industry.

The relocation of industries is not a new concept. Some would argue that planned relocation is not necessary as entrepreneurs, in the interest of maximizing profits, would themselves redeploy plants if there are financial advantages. It is after all a continuous process dictated by changing conditions. However, there are three main reasons to push the relocation argument more forcibly:

(i) Redeployment of industries takes place more rapidly and easily in a buoyant and expanding economy than a stagnant world economy; current world economic conditions are such that this process will be slow;

(ii) Governments in industrialized countries can provide support for affected firms by formulating forward-looking approaches to long term adjustment policies by limiting protective measures or at least by considering fixed timetables for the gradual withdrawal of special support and protection given to industries which cannot survive without such support and protection against imports from developing countries; they should acquaint their industry and labour with the considerable advantages which are available in developing countries.

(iii) It is important to stress to governments of developing countries that they should ensure conditions conducive to new co-operation arrangements, and to provide support for affected firms to seek out new investment opportunities. Much can be done through economic and regulatory measures.

5.7 Future prices and processing in the log exporting countries

The supplies from easily accessible tropical forests are decreasing. The World Bank estimates that the cost of production in new regions will be between 1.5 to 2 times higher than from present sources because of lack of infrastructure and low yields per hectare of forest. Although cost-reducing technologies and increased recovery are likely to mitigate these increases, it is safe to assume, barring a decline in the volume of demand, that the price of tropical hardwoods is going to rise in real terms. What are the ensuing consequences for domestic processing?

In the light of historical experience, the answer is not encouraging. Before World War II, the demand for hardwood in Europe and North America was filled by temperate species such as oak and beech. When these supplies began to dwindle and the price correspondingly increased, tropical species, primarily from West Africa, entered the world market. Again, the exploitation of the resource was not matched by sufficient replenishment; prices rose and by the late 1960s Southeast Asian species had priced most African species out of the market.[55/] The experience is likely to be repeated in Malaysia, Thailand and the Philippines when new supplies from the as yet unexploited forests of Central Africa, Papua New Guinea and parts of South America are brought into full production.[56/]

In none of these cases has the price increase for the domestic resource led to further domestic processing for the export market. Instead the importing countries have shifted their purchases to new supplies as soon as the price of the previous source became uncompetitive or supplies became irregular. The Philippines, Brazil and Indonesia have tried to prevent this development by establishing export controls on logs and compensating by increasing the degree of domestic processing of the material. As a counter move, Japan has started making direct investments in other countries to secure its long term supply of raw material.

[55/] The existence of grading rules, the increase in productivity in the South East Asia wood sector and the availability of regular and competitive shipping services to Europe also contributed greatly to the increasing competitiveness of South East Asian sawlogs and sawnwood.

[56/] Raj Kumar, "World Tropical Wood Trade - Ecconomic Overview", Resources Policy, September 1982, p. 181, 186.

Thus, increasing log prices have not led to greater retention of domestic supplies for local processing. Instead the resource has been exploited to its economic (financial) extent and cheaper raw materials are secured from foreign supplies.

We can also analyze the situation from the standpoint of the log importing countries. If increasing log prices in a traditional supply area had made processing there more profitable than in the importing country, processing would presumably have gradually shifted there. However, this did not happen. Experience has shown that large scale shifts in processing take place towards the areas where the necessary input (raw material or labour) has become relatively cheaper, not more expensive. Textiles and electronic assembly are two cases in point.

If log prices increase, the degree of domestic processing must be increased so as to add proportionally more value added and to absorb the increased raw material cost. This way the log exporting country can remain competitive in the wood sector markets.

A recent trend has been the fall in real prices of panel products, principally plywood, due to technological developments promoting an increased recovery and stiffer competition. However, due to higher costs of extraction as accessible forests are cut down, real prices for sawlogs are expected to rise. What would be the impact of these price expectations - if realized - for processing in developing countries? The price trends per se are not important, but rather the cost-price ratio. If higher productivity reduces costs and if the developing countries can be low-cost producers, there is opportunity for gain. Developing countries embarking on wood processing should therefore place special emphasis on cost as, given their comparative disadvantage in other areas such as research and technology, their capability to produce processed wood at lower costs than industrialized countries will determine their survival in the export markets. Otherwise, rising costs imply that exports of processed wood may be possible only if subsidized, which would not be beneficial in the long run.

5.8 Co-operation between developing countries in wood processing

The nature of wood processing differs depending on the circumstances of each supplier. For example, Singapore, the Philippines, Republic of Korea and Brazil are well established in the primary processing sector. Their immediate focus is now on extending integration and secondary processing. Other countries are currently building and consolidating their primary processing. The Republic of Korea, the Chinese Province of Taiwan, South Korea and Singapore have built up their wood processing industries on imported South Sea logs.

5.9 Institutional framework

Apart from infrastructural requirements and worker training, there is a need to review institutional arrangements. It has been noted in many developing countries that the secondary processing industry usually falls under the Ministry of Industry and is separated from the Department of Forestry or the Ministry of Agriculture, which administer the raw material and often control primary processing. The result has been a lack of adequate co-ordination necessary to stimulate a fast growing industrial wood sector. Bottlenecks in raw material supply to the domestic processing sector are common. Countries have tried to set up new institutions such as governmental boards to monitor and control the timber industry, e.g. the Malaysian Timber Industry Board, the Presidential Committee for Wood Industry Development in the Philippines, and the Ghana Timber Marketing Board. It is important that such institutions be given sufficient power to enforce their policies.

Programmes and policies involving many different government departments can have a great impact on the development of the wood sector. These include education, trade, taxation, building and construction programmes and policies and purchasing. It is then important that the impact on the wood sector be taken into account in all of these activities and deliberations. This points to the important role that an industry-wide association can play in promoting the interests of the sector.

5.10 Developing country oriented research

There is a difference in the orientation of research in the wood products industry in the developed and the developing countries. Although the forest products industry can in many aspects be considered a mature industry, the widespread application of new technology in developed countries is essential to remain competitive in world markets. In view of the normally bulky nature of wood products and the capital intensive nature of the sector, the emphasis is more on process than product development. The bias is in favour of substituting capital for labour. For the developing countries, the emphasis of industrial research should be on:[57]

(1) education and training to increase the skills of workers;
(2) developing or adapting products that will serve the needs of the developing countries;
(3) developing new cost saving technologies;
(4) increasing the volume of wood recovery from heterogeneous forests and enhancing quality;
(5) increasing utilization of lesser-used and lesser-known species;
(6) developing and promoting nomenclature, grading rules and specifications including use of mixed species groupings;
(7) increasing the utilization of wood wastes and residues;
(8) improving preservation and drying techniques;
(9) use of naturally occuring products for adhesives;
(10) use of locally available ancillary materials used in furniture (textiles, latex foams, etc.);
(11) the development of suitable surface finishing materials and methods;
(12) determining the optimal tool geometry for lesser used species;
(13) adaptating of machinery to prevailing conditions;
(14) improving and more widely distributing knowledge on structural designs for the use of wood in construction;

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[57] This list expands on that presented in UNCTAD TB/B/IPC/TIMBER/27, 1980, presented at the UNCTAD/FAO Fifth Preparatory Meeting on Tropical Timber, Geneva.

(15) finger jointing and other jointing and assembly methods;
(16) use of local products as fire retardants;
(17) development of locally available ancillary hardware for furniture;
(18) producing quicker growing trees, resistant to pests and diseases, suitable for monoculture plantations;
(19) genetic engineering of trees with very specialized wood characteristics e.g. resistance to termites, fungi;
(20) technology and mitigation measures to control the harmful environmental effects associated with harvesting and processing wood.

The promises of bio-technology and genetic engineering for forestry and the industry based upon it are at present largely only theoretical. To realize these potentials fully, and especially to complete successful pilot stages leading to commercially viable techniques and processes will require very large research efforts. If the past is to be repeated, such research will be done only within the largest corporations and in the richest countries, and only with respect to species and applications that are of immediate interest to the industrialized world. To prevent the developing countries from once more being left behind, R & D in bio-technology and genetic engineering ought to be done on an international level, suitably by international research institute experiment stations in many countries and ecological zones. The International Union of Forestry Research Organization (IUFRO), in Vienna is also working to promote international co-operation in forestry research through more than 200 Scientific Research Units.

CHAPTER 6 Marketing and Product Promotion

6.1 Introduction

As a developing country increases the degree of processing of its forest resources, the industrialization process itself becomes more sophisticated and greater demands are put on the promotion and marketing of products. When other countries have access to the domestic market of a developing country, or when the latter tries to penetrate external markets, there is a need to be competitive in price and quality as well as technologically innovative to forstall competition from substitutes; to intensify promotional efforts in both domestic and export markets in order to expand output and increase the utilization of the entire resource; to improve transport and distribution channels; and to standardize and organize market information.

Attention to these factors will increase the popularity of tropical wood products in both the domestic and international markets and result in larger volume flows, better quality and price competitiveness and more effective distribution.

6.2 Wood products and their substitutes

The future viability of wood based industry rests on its ability to be technically efficient and competitive in relation to substitute products. This, of course, applies to any industry. But it takes on a particular significance in the wood and wood processing industry because of the relatively high substitutability both among products within the industry and vis-à-vis products of other sectors[58/]. Wood based panels have often replaced sawnwood in building construction and furniture, and in recent years particle board and fibreboard are being increasingly substituted for plywood

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[58/] see., e.g. J. Zarembo, Economics of the American Lumber Industry, U.S.A., 1963; L. Runeberg, Plastics in Competition and Co-operation with Forest Products in Readings in Forest Economics (ed. A. Svendsrud, Oslo, 1969); and R. Kumar, "A Quantitative Analysis of the Elasticities of Export and Home Demand of Key Malaysian Wood Products", Kajian Ekonomi Malaysia, Vol. XIV, No. 1, 1982.

and, to a lesser extent, for solid wood. In construction, the main non-wood substitutes are steel, aluminium, bricks, concrete, and glass. In furniture making, plastic, steel and aluminium are replacing wood components. In packaging, various plastic products and paper and cardboard have replaced wood in many applications. Table 6.1 summarizes the main uses of tropical wood and their substitutes.

Substitution among wood products and between wood and non-wood products is a continuing phenomenon . This implies a need to be constantly alert to changing market conditions and cost structures as well as to new technologies in order to ensure market success. Factors that affect substitution operate on both the supply and demand sides. Technology and cost of production are the main supply side variables. On the demand side, the relative price of the wood based products, income levels, and consumer preferences are the most important factors. Significantly, however, the impact of most of these factors is controllable to some extent by the producer. New technology can be adopted or adapted, and designs can be changed to suit changing income levels and preferences. But the pressure from rising prices of the raw material itself will be increasingly felt as forest resources are depleted. This can be countered by improvements in technology. Examples of such a technological evolution are the development of plywood as a substitute for sawnwood, particle board as a substitute for plywood, etc. Such evolution is continuing with the development of waferboard and oriented strand board.

In the manufacture of plywood, a variable raw material is transformed into a product that is stronger and more versatile than the wood from the original tree. Moreover, the log recovery rate is increased and mill residues are put to use. Clearly, this has kept costs down and helped plywood maintain a competitive market position vis-à-vis new products such as particle board and fibreboard.

Thus, technology has helped wood products to stay competitive with their substitutes, and it must be expected that this role will only increase. But technology has also created non-wood substitutes (plastics for example) that have clearly affected the consumption of wood products. Of course such

Table 6.1 Tropical wood products, main uses and substitutes

Wood product	Main uses	Wood substitutes	Non-wood substitutes
Sawnwood	Construction (structural building elements, flooring, walls, joinery, panelling, scantling and lining)	Veneer, plywood, (mainly in panelling, joinery, furniture flooring) Paper, paperboard and fibreboard(mainly in packaging), and particle board	Concrete, bricks, steel, aluminium, (construction, engineering) Plastic (furniture, packaging)
	Engineering (bridges, wharves piers, piling, railway sleepers, mining timbers)		
	Furniture Packaging (boxes, crates, pallets, dunnage) Vehicles Other Miscellaneous		
Veneer and plywood	Construction (walls, doors, decorative panelling)	Sawnwood (as above) Paper overlay (panelling and packaging)	Polyester overlay, fibreglass, concrete (construction), plastic (furniture, packaging)
	Packaging (crates, boxes, tea chests)	Particle board Fibreboard	
	Furniture Vehicles (boats, caravans) Miscellaneous (toys, etc.)		Steel, aluminium (construction)
Particle board and blockboard	Construction (building elements, walls, panelling, underfloor)	Sawnwood, veneer and plywood (packaging, construction and furniture) Fibreboard	Steel, aluminium and concrete(construction) Plastic (furniture and packaging)
	Packaging (boxes, crates) Furniture		

Source: Adapted from "World Tropical Wood Trade- Economic Overview", op. cit., p. 179.

technological progress should not be halted in the interest of the wood sector. A much more fruitful way of approaching the problems created by new technologies and new non-wood products is to look for complementary uses for wood. The symbiotic relationship between plastics and timber is exemplary, and in sheet products plastics and wood fibres are combined often usefully[59/]. Another way in which plastics affect the demand for wood products is that they have substituted not only wood but also other products like aluminium that are competitors of wood. From a long term point of view, however, wood products may well outlive most if not all of their present day 'modern' substitutes because, after all, they are based on a renewable resource whose long run resource cost prospects are much better than those of exhaustible resources.

There is, of course, a degree of substitutability between hardwoods and softwoods, but with the increased use of reconstituted wood chips and fibres, the contrasting features of softwood and hardwood have been largely obscured by technology[60/]. The softwoods and hardwoods, particulary from forests in Europe and Australia, have found a high degree of complementarity in their application. Although competition is still prevalent, it is often less accentuated, frequently occuring in specific sectors for particular uses and properties.

Today, overwhelmingly the largest use of wood in the developing countries is for fuel. In many regions, the supplies of fuelwood have dwindled dramatically with consequent rises in price (and detriment to the ecology. Therefore, the case has been made for a policy to substitute coal or some other energy source for fuelwood and charcoal . In China, the switch to coal has largely taken place, and this option is becoming increasingly relevant for

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[59/] See L. Runeberg, "Plastics in Competition and Co-operation with Forest Products", Readings in Forest Economies, (ed. A. Svendsrud), Oslo, 1969.

[60/] T.H. Erfurth, "Competition between softwood and hardwood in the European Market", Paper presented at the 2nd Malaysian National Timber Congress, March, 1979, Kuala Lumpur, 1979.

some other countries as well.[61] In the USA, however, wood use as a fuel is currently undergoing a comeback.

6.3 Promotion of the use of wood and wood products

Unlike technology, preferences for and against wood are dependent on sociological, and psychological factors. In some rich countries, for instance, there is a certain 'snob' appeal in having wooden furniture or wood panelling. Habit, fashion and custom are decisive factors in the use of wood in buildings. Yet in some developing countries, there has been a decline in the use of timber for residential housing because wooden houses are traditionally associated with poor people. Social prejudices and values change or can be changed through a variety of educational and similar efforts, which in the following text is referred to collectively as 'promotion'. The promotion efforts should try to foster a more favourable image for wood. Above all, this entails the demonstration of the suitability of wood in applications hitherto untried or little used in particular regions. The efforts to shift consumption from wood substitutes to wood based products through advertising and promotion can be made easier if product and quality standards are maintained and innovations are made in design and presentation of manufactured products. Meaningful demonstration projects are likely to be needed to set forth effectively the use and advantages of wood especially in housing construction in both urban and rural areas in the developing countries. Various self-help and sites-and-services schemes ought more often to stipulate wooden materials rather than concrete and asbestos.

Such promotion requires preparatory work in product design to improve the fire and fungs resistance of tropical woods in a cost-effective manner. Parallel to this, building codes must be updated.

Much missionary work is needed to promote the use of commercially less accepted species by effectively disseminating the undoubtly vast amount of information that exists. In the collecting and disseminating of this information, more attention must be given to the grouping of wood species and to the establishment of end-use classification systems that emphasize end-use requirements. There is also a need to standardize the names for the presently lesser known species. Presently the use of local names that differ from region to region makes both the enumeration and the promotion of these species unnecessarily difficult.

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[61] A.V. Buren and G. Foley, "Substitutes for wood", Unasylva, Vol. 32, No. 130, 1980, pp. 11.24.

On a purely technological level, there appears to be a lack of specific research on the processing and manufacturing use of commercially less accepted species, and further technological development is needed on the use of locally available tannins as resins. However, such research can be expensive and the results by no means assured; therefore, in the interestes of furthering the industrialization in the developing countries, this research should be undertaken or supported by the international community.

6.4 Development of markets for producers in developing countries

6.4.1 The importance of the local market[62]

The possibilities of increased processing in the developing countries depend on the existence of markets and on the capability to produce for these markets. Countries with well developed local markets for wood products have an advantage in the primary and forestry components of the wood processing sector. In forest management the advantage results from being able to use a greater proportion of the wood raw material thus justifying more intensive - and extensive - forest management efforts. The advantages for the primary sector result from the ability to sell a wider range of products. It is thus possible to recycle wastes from the manufacture of plywood and sawnwood into fibreboard, blockboard and particle board which, because of scale economics could not be readily exported. It is also possible to market lower grade sawnwood and plywood that contain material from species that are not well established in international trade. These products may be perfectly acceptable for some domestic applications, but are not usually competitive in international markets because their relatively low values will not bear shipping costs because their characteristics are not well known overseas. Another reason might be that they cannot be produced in sufficient quantities. Further, it may be possible to facilitate the introduction ofprocessing techniques and test applications for commercially less accepted species by concentrating on producing for the domestic market before undertaking the risk and expense of introducing them into international markets.

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[62] In many countries or regions, the local market is so small and/or homogenous that it is more appropriate to refer to the regional market; in this study, then, "local" or "domestic" implicitly refer to a regional market, where appropriate.

Domestic markets for wood products in the developing countries can be expanded through appropriate promotion, especially in primary processing for use in the housing and construction sectors. This will entail the adaptation and/or design and development of products to local tastes, customs and building and other codes, the vigorous use of demonstration projects, technical research on wood preservation, and efforts to increase the acceptance of species that are presently commercially less accepted and to develop the uses of lower value woods.

The standardization of building materials and utility furniture is best done on a regional rather than global scale because of historical development and geographically/culturally varying requirements. However, a good starting point would be the developing countries themselves where standards and practices may not be well established, although being unaccustomed to standards may also prove in itself a difficult obstacle.

6.4.2 The export markets

Developing an export market is important not only for the obvious reason of earning much needed foreign exchange, but also in order to expand output. Developing countries have comparative advantages that can be utilized on the international markets. However, marketing -not technology- becomes the overriding factor determining success.

Whereas the emphasis on developing the local markets is on increasing the local use of wood products, the focus on adaptation of products to export markets is on meeting standards and on price and quality competitiveness.

For success in the export market, a developing country producer of wood products must convince the potential importer that his (tropical hardwood) product is at least as good as the product presently in use. Tropical hardwoods do have several advantages over softwoods and certain other construction materials; these include durability, appearance, and sometimes quality consistency. For the importer, it is important that the product be available on a continuing basis. It does not pay to promote a new product only to find out that once demand has built up, the required volume does not exist. Likewise, it is of great importance that the quality be constant and that price and delivery terms be adhered to as agreed.

It is well to note here that a log exporter in a developing country ought to avoid using his log importing agent to market his processed wood products unless this agent is also established in the trade of processed wood. The marketing channels, and hence the vital contacts, are very different for unprocessed and processed wood products, and the difference between the use of the right and wrong marketing channel is the same as that between success and failure on the export market.

The questions of grading and standardization are very important for the industrialization of the wood sector in the developing countries. Present specifications are often out-of-date with today's technology. Local and national building codes are also often outdated and constitute unnecessary obstacles to the greater use of wood in construction. Some of these codes and standards are clearly protective of another industry.

In the furniture sector, the lack of skilled designers able to provide not only fashinable but ergonomically correct designs is a current problem in developing countries. It is most acute in the export oriented part of the industry. One solution, and probably the one most appealing for developing countries, is to focus their export oriented furniture production on the utility part of this market. Despite the emphasis on the question of style and fashion that seem to prevail in the trade literature, it is important to note that a very large part of the market consists of utility furniture which emphasize function, ergonomics, economy, and well established designs which change only slowly over time. These design changes also tend to change more as a function of new auxiliary materials, production innovation, and changes in economic condition than as a result of changes in consumers' tastes which characterize the fashion portion of the industry.

This approach involves selecting those products for which the capabilities of the firm are most suited and determining whether their costs will put them in a competitive position in the international market. It then becomes a matter of finding the suitable marketing channel. Here production for or sale to large retail or wholesale outlets in the developed countries have proved fruitful for developing country producers. However, the importance of maintaining agreed upon quality and standards, as well as delivery schedules cannot be overemphasized for the longer term viability of such agreements. In this respect, there have been both good and bad experiences. A recent and successful form of conducting furniture exports is through the producer's own import distribution organization. Sometimes this is combined with an assembly operation where imports in knock-down form from the developing country are put together for retailing. The exporter can establish his own company or it can be a joint venture with an established partner in the importing country. A final step on this integration would be the establishment of the exporter's own retail outlets in the importing country.

In all promotional activities, whether directed towards the domestic or the export market, there is great scope for work by trade and manufacturers' associations, and where these are weak or lack expertise international agencies should provide them with technical assistance and marketing information.

The marketing function will be a difficult one to perform for the typically small enterprise in the wood processing sector. Smaller companies must examine all possible mechanisms available to them for marketing their products. These include contracting with larger firms or using independent agents and brokers. Another option would be to join with other firms with similar objectives to organize a trading company that can provide essential export marketing services to all of the member companies. Multinational trade organizations such as SEALPA (Southeast Asian Lumber and Plywood Association) can also provide valuable assistance in these respects. It would appear that this would be an area of prime interest for new Third World multinational enterprises.

6.4.3 Foreign participation in projects

Developing countries that wish to attract foreign investment should clearly define the terms and conditions on which investment proposals would be acceptable. A foreign investor would need information on the following, inter alia, in clear and properly quantified terms:

1. What assurances can be given that supply of raw material will be available to the wood processing plant for a period compatible with the life of equipment?
2. What domestic and export markets are envisaged?
3. What tax regime and other investment incentives are available to allow for faster payback?
4. What are the conditions for repatriating earnings and for obtaining foreign exchange to buy spare parts, etc.?
5. What infrastructure (transport, manpower and utilities) is available?
6. What are the facilities to obtain work permits and concessions available to expatriates involved in the project?

A well-documented promotion package can facilitate quick decision making and at the same time focus on the issues necessary to promote a viable industry. It has to be stressed that in reality decisions on whether or not a particular processing industry is set up are based on critieria at the firm level.

6.5 Market intelligence to harmonize and improve information dissemination

To understand the importance that is being attached to market intelligence, it is useful to summarise the key features of the tropical wood trade which is of main interest to developing countries. These are: shifting sources of tropical wood supplies and preferred species due to low level of replenishment, greater domestic processing of the industrial raw material, a marketing structure for sawlogs and sawnwood based on species rather than end-use performance, and trends towards product standardization particularly for wood based panels. These features produce a market structure unlike those of softwood or other natural resources, or even agricultural products. The tropical hardwood trade is very specialized, almost custom built with demand often tied down to exact specifications for each transaction. The flow of the raw material tends to depend heavily on the reputation and reliability of traders, delivery schedules and negotiating abilities. Most non-coniferous sawnwood importers, for instance, rarely handle volumes in excess of 20,000-25,000 cubic metres a year, whereas some softwood importers could trade this amount in one month. The softwood trade is usually conducted by large firms (including transnationals) and brokers, whereas hardwood traders are usually small and normally deal in a variety of species, specifications and grades for given end-uses.[63/]

This set-up of the hardwood trade has given rise to a long series of discussions organized by FAO and UNCTAD on the need to improve market information on tropical timber through the creation of a Tropical Timber Organization. An all embracing term, "market intelligence", has been used to denote the "continuous and systematic collection, collation and dissemination of information to support the planning and executing of marketing activities".[64/] Intelligence activities also include information on selected subjects such as product development, market acceptance, market structure, end-use studies, and grading rules. In other words, the stress is on information that is not periodically available.

There will have to be an international effort with producing and consuming countries facilitating the collection and release of such data. Besides UNIDO,

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[63/] J.T. Wassink, Notes on the Marketing of Tropical Hardwood, Royal Tropical Institute, Amsterdam, 1977; T.H. Erfurth op cit.; R. Kumar, op cit.

[64/] UNCTAD, Improving Market Intelligence Activities for Tropical Timber, TD/B/IPC/TIMBER/31, Geneva, 1980.

UNCTAD and the FAO, it is felt that the proposed International Tropical Timber Organization will be able to play the role of collecting, collating and disseminating this information on a systematic and periodic basis. Meetings between producers and consumers to exchange views on the market situation and prospects are organized yearly in Europe for the softwood trade, but no such meetings are held for the hardwood trade other than those of ATIBT, which are at a more technical level.

The developing countries in particular have been supporting what has been described as "an early warning system" to "inject as much predictability as possible into the hitherto highly unpredictable market".[65/] The problem is the difficulty of devising an indicator or any kind of automatic trigger that would act as a warning signal without misleading the trading partners. There is the belief that if market intelligence could be improved, it could form the basis of such an early warning system provided it included a comprehensive analysis of the current supply and demand situation of importing countries. A suggested proposal comprising monitoring, evaluation and consultation as an interrelated package for concerted action between producers and consumers has been suggested.[66/] It is hoped that it would also permit early detection of the symptoms of any serious imbalance in the supply and demand sitation in the international tropical timber market.

Strong national associations in the developing countries can increase the use of wood and wood products within both producing and importing developing countries. Such associations could best foster both the promotion of improved production technology and higher utilization of wood and wood products, especially where more institutional aspects such as building codes are involved. Developing and strengthening these associations should receive high priority in promoting the wood and wood processing sector.

65/ UNCTAD, Consideration of Proposals for the Improvement of Market Intelligence on Tropical Timber, TD/B/IPC/TIMBER/AC.2/2, Geneva, 1981.

67/ UNCTAD, Report on the Intergovernmental Group of Experts on Improvement of Market Intelligence on Tropical Timber, TD/IPC/TIMBER/34, Geneva, 1982.

CHAPTER 7 Conclusions regarding the development of primary and secondary wood processing industries and measures to promote the use of wood and wood products.

This section sets out the main conclusions that can be drawn from the analysis of the preceding chapters. For the sake of brevity and clarity, the conclusions are formulated briefly and without the corresponding substantiation.

A clear conclusion from this study is that the wood and wood products sector can play an important role in the development strategies of many developing countries. The sector has economic potential in many instances which derives from the presence of raw materials and low-cost labour, as well as relatively low capital and imported energy requirements. Further, the sector does not require a highly sophisticated production technology or large-scales of operation. The industry's rural character, at least in parts, is very well suited for the overall economic development strategies of the developing countries.

7.1 The need for a systemic approach

- The wood and wood processing industry is part of a larger wood or forestry system and of a still larger socio-economic system. Within the forestry system, the multiple use of the resource is a key target. Any action with regard to the industry will affect other parts of the system and vice versa. It must be ascertained that the impact of any action in any part of the system is in line with overall targets and preferences for the multiple use of the resource. This is necessary also when appraising the possibilities of further wood processing in developing countries, given the great importance of the forest resources to human well-being.

- In parts of the world the ecological balance is threatened, if not already damaged beyond spontaneous recovery, because of lost natural forest cover.

- The wood processing industry is particularly important to the rural population, a fact which is increasingly recognized in development strategies.

- Forest management policies should be seen as a part of general development policies.

7.2 The resource and its utilization

- World forest resources are distributed between developing and industrialized countries roughly in proportion to population. But the industrial use and benefits are disproportionately distributed.

- The world's forest resources are relatively less utilized in the developing contries. The dominating use there is for fuel wood; industrial use is small, although increasing.

- In the long run, world forest resources are continuously declining. Present trends indicate accelerating depletion during coming decades. This is not caused by industrial use, but by shifting agriculture, grazing, urbanization, natural disasters, etc. Industrial use, on the contrary, is a very efficient way of getting high return from limited use of the resource.

- There is a need to increase the utilization of presently commercially less accepted species.

- There is a need in developing countries for long-term plans for the allocation of land between agriculture and forestry.

- Only a limited part of the world's forest resources is under active forest management. Improved and extended forest management has a central role in achieving increased yield as well as efficiency in the utilization of forest resources.

- There is a need for more and better inventories of the forest resources of the developing countries, including the use of uniform nomenclature.

- In a perspective for the year 2000, it appears likely that total demand could be met by an adequate global supply. There will, however, be severe regional bottlenecks and shortages, and the industry in some countries may run into problems of raw material supply.

- Presently, data on utilzation by species are completely missing, or are spotty. The wood and wood processing industry could make good use of such data.

7.3 The potential of developing countries to expand wood and wood processing industries.

- In both primary and secondary wood processing, the developing countries have a competitive edge over other countries for certain products because of the relatively labour intensive character of parts of the industry. Labour costs are lower in the developing countries and, as a rule, even lower in wood processing than in many other sectors of manufacturing industry. On the other hand, the often prevailing lack of adequate skills and lower productivity reduces this advantage.

- From the point of view of energy, the wood processing sector is in an advantageous position. Its own energy requirements are low, and it has a great potential for achieving a high degree of energy self-sufficiency and/or becoming a supplier of energy to other sectors.

- There are some environmental hazards connected with deforestation, inappropriate logging and harvesting methods, and the disposal of waste material. In the preservation of wood toxic chemicals are used that, if not disposed of properly, are harmful to the environment. In the design of new facilities and processes it is important that environmental safeguards are included from the beginning.

- The frequency of accidents is higher in this sector than in manufacturing as a whole. Occupational health and safety problems in this sector in the developing countries are increased by the lack of safety equipment and inadequate attention to safety on the part of both workers and management. Safety regulations that do exist are often not enforced.

- The constraints in developing the wood and wood processing industry in the developing countries are mainly related to the availability of skilled labour, operators and supervisors, availability of equipment adapted to local conditions, poor quality of products produced, low productivity, trade barriers, and difficulties in gaining acceptance for secondary or commercially less accepted species.

- The potential comparative advantages of developing countries are also large in secondary processing. This sector has not been developed a great deal in these countries, but lately has increased in significance.

- Whereas economies of scale in secondary processing are not always predominant, they do play a role when it comes to repair and maintenance, marketing and other types of specialist services. Co-operation between enterprises or between countries is therefore necessary to make such services available and to reduce their unit costs.

- Increased use of wood in building and construction could play a significant role in enlarging local markets for wood and wood products. However, in some societies certain technical problems (e.g. relating to humidity and decay) as well as financial discrimination, social prejudice and legal constraints first must be overcome.

- Integrated processing is the key factor in achieving a better utilization of available resources. Integration can be undertaken stepwise, by successively adding new products which either make use of or contribute to the production of already existing units. The use of wastes or residues as raw material or as an energy source are crucial in the integration process. However, it is usually preferable not to attempt large-scale, in-plant integration in industrial complexes, but rather by chaining, wherever possible, relatively small and functionally independent units.

7.4 Measures to promote the use of wood and wood products

- The markets for wood products in many developing countries are, for both technical and non-technical reasons, not well developed. The spontaneous expansion of these markets can be accelerated through product design, promotional work and technological development/adaptation.

- Substitution among wood products and between wood and non-wood products is significant. It is a continuous phenomenon that must be constantly monitored to assure survival on the markets.

- The use of presently commercially less accepted species must be promoted in order to increase utilization of the tropical forest. This would also enable export of additional quantities of the desired species which otherwise would be consumed locally.

- Good possibilities to increase the degree of industrial processing of wood in the developing countries lie in proceeding via the domestic market to the export markets.

- To penetrate the world's export markets, the selection of proper marketing channels becomes the overriding concern. Initial options include an agent or a foreign partner. With gained experience, the developing country producer can later divest himself of such agreements.

- Manufacturers' associations and trade organizations can do a great deal to promote products from developing countries. Recognized quality assurance schemes are be important for product promotion.

- Shipping can constitute a significant cost element in the exporting of wood and wood products. Specific purpose ship designs and appropriate bundling and containerization of cargo are the most obvious means to reduce these costs.

- Port and road infrastructure improvements are needed to facilitate the increased use of certain species.

7.5 Trade related questions

- Trade among developing countries is small, especially in manufactured products. This has an adverse effect on promoting the industry in these countries.

- Tariff escalation is a significant factor in discouraging further processing in developing countries.

- Recent restrictions (bans) on the export of logs has affected the traditional flow of raw material to the developing countries involved in intermediate processing.

- There are many non-tariff barriers facing exports of wood products from the developing countries. These include quotas as well as health, sanitary and technical standards. Because they are less transparent and frequently changing, they tend to impede trade more effectively than ordinary commercial tariffs.

7.6 Technology

- Developing countries need technical assistance for the evaluation and selection of appropriate technology. The level of technology must be appropriate not only to the type and scale of production, but also to the local resource endowments, infrastructure, capital, labour and management skills and maintenance possibilities.

- Many necessary improvements have been identified, for example, in the field of material handling, standardization, grading, machining, glueing and finishing technology, drying, preservation and industrial engineering.

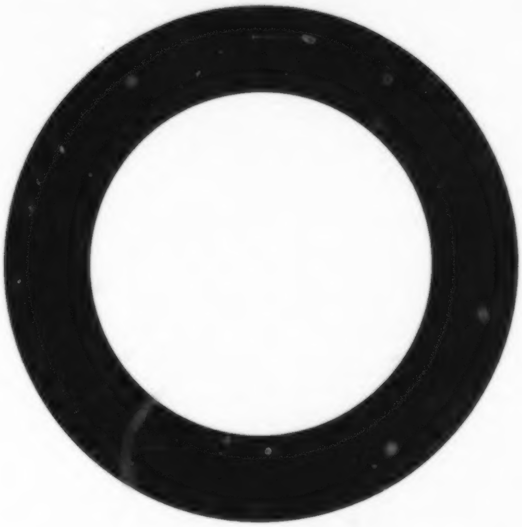
- Technologies for the use of commercially less accepted species need additional development and dissemination, especially relating to the grouping and processing of mixed species. End-use oriented research and a species grouping classification system related to end-use applications are required.

- The high-technology option should not be discarded out of hand.

7.7 Research

- Large amounts of research results are available in institutes and other bodies in industrialized countries and in some developing countries. This knowledge must be disseminated effectively to the interested parties in the developing countries, necessitating appropriate international co-operation programmes.

- Research needs to be moved closer to the resource, that is to say to the developing countries.



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Appendix : Direction of Trade

Appendix Table 1. Direction of trade: sawlogs and veneer logs (Coniferous) SITC 217.1, ($1000m^3$)

MAJOR EXPORTERS / MAJOR IMPORTERS	[1] WORLD EXPORTS	DEVELOPED	USA	USSR	Canada	New Zealand	Czechoslovak	Finland	Germany FR	Switzerland	Belgium Lux	Norway	Others	DEVELOPING	Chile	Indonesia	Others			[2] WORLD IMPORTS
1980																				
WORLD	28072	26584	14084	6514	1050	970	884	691	507	499	341	313	731	1488	1004	298	186	-	-	27930
DEVELOPED	25421	24773	12733	6514	1041	774	884	513	505	499	341	313	656	648	350	217	81	-	-	25490
Japan	18622	18067	11473	5178	643	773	-	-	-	-	-	-	-	555	338	217	-	-	-	17172
Canada	1239	1239	1239	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1629
Italy	763	759	5	-	-	-	136	1	188	429	-	-	-	4	4	-	-	-	-	1492
Austria	886	886	1	153	-	-	478	-	244	10	-	-	-	-	-	-	-	-	-	1084
Germany FR	639	639	3	34	-	-	239	40	-	2	319	2	-	-	-	-	-	-	-	730
Finland	654	654	-	654	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	654
Hungary	595	595	-	431	-	-	15	147	2	-	-	-	-	-	-	-	-	-	-	647
Sweden	685	685	-	62	-	-	-	325	-	-	-	298	-	-	-	-	-	-	-	549
USA	398	398	-	-	398	-	-	-	-	-	-	-	-	-	-	-	-	-	-	517
Others	940	851	12	2	-	1	16	-	71	58	22	13	656	89	8	-	81	-	-	1016
DEVELOPING	2651	1811	1351	-	9	196	-	178	2	-	-	-	75	840	654	81	105	-	-	2440
Korea Rep	1550	1062	906	-	9	147	-	-	-	-	-	-	-	488	488	-	-	-	-	1518
China	611	447	398	-	-	49	-	-	-	-	-	-	-	164	162	2	-	-	-	609
Others	490	302	47	-	-	-	-	178	2	-	-	-	75	188	4	79	105	-	-	313
1981																				
WORLD	22968	22157	10768	6198	908	529	866	742	489	373	366	191	727	811	359	288	164	-	-	23057
DEVELOPED	20429	20055	8971	6198	902	509	866	552	487	373	366	191	640	374	69	242	63	-	-	20538
Japan	14201	13919	8012	4815	595	497	-	-	-	-	-	-	-	282	40	242	-	-	-	13388
Canada	987	987	987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1277
Italy	662	662	3	7	-	-	133	45	135	339	-	-	-	-	-	-	-	-	-	1338
Austria	967	967		154	-	-	510	-	293	10	-	-	-	-	-	-	-	-	-	1114
Germany FR	554	554	2	6	-	-	191	17	-	2	332	4	-	-	-	-	-	-	-	636
Finland	520	520	-	509	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	520
Hungary	540	540	-	463	-	-	6	71		-	-	-	-	-	-	-	-	-	-	570
Sweden	455	455	-	20	-	-	8	253	-	-	-	174	-	-	-	-	-	-	-	422
USA	299	299	-	-	299	-	-	-	-	-	-	-	-	-	-	-	-	-	-	397
Others	1284	1192	7	224	8	12	18	166	59	22	34	2	640	92	29	-	63	-	-	876
DEVELOPING	2539	2102	1797	-	6	20	-	190	2	-	-	-	87	437	290	46	101	-	-	2519
Korea Rep	935	678	678	-			-	-	-	-	-	-	-	257	257	-	-	-	-	1170
China	1110	1032	1007	-	6	19	-	-	-	-	-	-	-	78	32	46	-	-	-	1051
Others	494	392	112	-	-	1	-	190	2	-	-	-	87	102	1		101	-	-	298

1/ Volume identified with specific exporters
Volume provenant d'exportateurs identifiés
Volumen indicado por los exportadores

2/ Volume reported by importers
Volume indiqué par les importateurs
Volume indicado por los importadores

Source: Yearbook of Forest Products, 1970-1981, FAO, Rome, 1983

Appendix Table 2. Direction of trade: sawlog and veneer logs (Non-coniferous), SITC 247.2 (1000m^3)

MAJOR EXPORTERS / MAJOR IMPORTERS	WORLD EXPORTS[1]	DEVELOPED	France	USA	Others	DEVELOPING	Malaysia	Indonesia	Ivory Coast	Philippines	Gabon	Cameroon	Papua NG	Liberia	Others					WORLD IMPORTS[2]
1980																				
WORLD	42140	3441	800	688	1953	38699	15146	14884	3065	1154	1095	741	642	475	1497	.	.	.	.	42178
DEVELOPED	28492	3316	792	642	1882	25176	8859	8738	2844	1154	1032	641	480	460	968	.	.	.	.	28734
Japan	19140	52	.	52	.	19088	8846	8564	.	1154	15	41	465	3	.	.	.	.	.	19202
Italy	1428	318	266	52	.	1110	6	56	958	.	22	54	9	5	.	.	.	.	.	2800
France	1315	10	.	10	.	1305	3	23	611	.	413	93	.	162	.	.	.	.	.	1776
Germany FR	894	430	177	253	.	464	4	16	177	.	97	93	.	77	.	.	.	.	.	1201
Spain	750	76	72	4	.	674	.	.	391	.	88	114	.	81	.	.	.	.	.	793
Canada	202	200	.	200	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	410
Others	4763	2230	277	71	1882	2533	.	77	707	.	397	246	6	132	968	.	.	.	.	2552
DEVELOPING	13648	125	8	46	71	13523	6287	6146	221	.	63	100	162	15	529	.	.	.	.	13444
China	6307	.	.	.	.	6307	3642	2655	.	.	.	.	10	.	.	.	.	.	.	6447
Korea RP	3838	8	.	8	.	3830	1676	2047	.	.	.	.	107	.	.	.	.	.	.	4623
Singapore	1107	1	.	1	.	1106	304	789	13	.	.	.	.	.	.	.	.	.	.	1117
Hong Kong	1015	.	.	.	.	1015	655	355	.	.	.	.	5	.	.	.	.	.	.	570
Others	1381	116	8	37	71	1265	10	300	208	.	63	100	40	15	529	.	.	.	.	687
1981																				
WORLD	33361	3196	808	712	1676	30165	15854	6221	2343	1437	1095	665	749	475	1326	.	.	.	.	33999
DEVELOPED	22611	3087	804	662	1621	19524	8613	3810	2199	1437	1006	661	499	455	844	.	.	.	.	22987
Japan	14370	25	.	25	.	14345	8613	3767	3	1437	1	29	495		.	.	.	.	.	14994
Italy	1213	361	340	21	.	852		10	771	.	17	43		11	.	.	.	.	.	2359
France	1125	8	.	8	.	1117			457	.	502	67	.	91	.	.	.	.	.	1462
Germany FR	838	505	135	370	.	333			149	.	40	69	.	75	.	.	.	.	.	862
Spain	420	64	61	3	.	356	.	.	224	.	52	66	.	14	.	.	.	.	.	467
Canada	174	174	.	174	.		.		.	.	.	.	.	.	.	.	.	.	.	356
Others	4471	1950	268	61	1621	2521	.	33	595	.	394	387	4	264	844	.	.	.	.	2487
DEVELOPING	10750	109	4	50	55	10641	7241	2411	144	.	89	4	250	20	482	.	.	.	.	11012
China	4400	.	.	.	.	4400	3179	1221	.	.	.	.		.	.	.	.	.	.	4521
Korea RP	3541	9	.	9	.	3532	2982	352	1	.	.	.	197	.	.	.	.	.	.	4388
Singapore	752	2	.	2	.	750	315	431		.	.	.	4	.	.	.	.	.	.	776
Hong Kong	827	.	.	.	.	827	605	216	.	.	.	.	6	.	.	.	.	.	.	570
Others	1230	98	4	39	55	1132	160	191	143	.	89	4	43	20	482	.	.	.	.	757

1/ Volume identified with specific exporters
Volume provenant d'exportateurs identifiés
Volumes indicado por los exportadores

2/ Volume reported by importers
Volume indiqué par les importateurs
Volume indicado por los importadores

Appendix Table 3. Direction of trade: sawnwood (Coniferous) SITC 248.2 (1000m³)

MAJOR EXPORTERS / MAJOR IMPORTERS	1 WORLD EXPORTS	DEVELOPED	Canada	USSR	Finland	Sweden	USA	Austria	Czechoslovak	Portugal	Poland	Others	DEVELOPING	Chile	Others					2 WORLD IMPORTS
1980																				
WORLD	66058	63630	28966	7131	6898	5889	4647	4247	1044	893	689	3226	2428	1258	1170	.	.	.	.	62801
DEVELOPED	57557	57007	28033	5677	5842	5096	3604	3544	977	799	566	2869	550	285	265	.	.	.	.	56798
USA	22113	22113	22109	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	22169
UK	5768	5768	1581	1014	1285	985	126	12	162	377	226	.	.	.	.	.	.	.	.	5983
Japan	4397	4359	2578	134	.	.	1496	.	151	.	.	.	38	38	.	.	.	.	.	4892
Germany FR	3791	3721	238	533	944	904	167	677	.	130	128	.	70	70	.	.	.	.	.	4505
Italy	4277	4257	235	425	224	317	439	2477	133	2	5	.	20	20	.	.	.	.	.	4369
France	2479	2441	575	359	773	480	34	12	33	57	118	.	38	38	.	.	.	.	.	2631
Netherlands	2392	2366	110	212	939	804	23	42	76	139	21	.	26	26	.	.	.	.	.	2412
German DR	1316	1316	.	1312	.	1	.	2	1	.	.	.	.	.	.	.	.	.	.	1271
Denmark	1211	1211	12	86	485	606	10	.	.	2	10	.	.	.	.	.	.	.	.	1232
Belgium lux	905	858	172	232	249	49	62	2	.	67	25	.	47	47	.	.	.	.	.	1032
Hungary	791	791	2	645	70	17	.	32	25	.	.	.	.	.	.	.	.	.	.	815
Spain	593	593	13	83	124	262	110	.	.	1	.	.	.	.	.	.	.	.	.	692
Australia	528	528	308	.	7	.	213	.	.	.	.	.	.	.	.	.	.	.	.	690
Canada	860	860	.	.	.	.	860	.	.	.	.	.	.	.	.	.	.	.	.	670
Others	6136	5825	100	642	742	667	64	288	396	24	33	2869	311	46	265	.	.	.	.	3435
DEVELOPING	8501	6623	933	1454	1056	793	1043	703	67	94	123	357	1878	973	905	.	.	.	.	6003
Saudi Arab	716	670	109	112	23	272	97	55	.	2	.	.	46	46	.	.	.	.	.	898
Egypt	1067	1067	220	214	283	246	91	.	9	.	4	.	.	.	.	.	.	.	.	823
Lat America	1449	927	177	.	10	1	739	.	.	.	.	.	522	522	.	.	.	.	.	2000
Others	5269	3959	427	1128	740	274	116	648	58	92	119	357	1310	405	905	.	.	.	.	2282
1981																				
WORLD	60789	58935	27293	6925	5377	5624	4477	3787	1090	780	565	3017	1854	847	1007	.	.	.	.	57893
DEVELOPED	52697	52561	26205	5658	4519	4696	3219	3330	1049	709	483	2693	136	62	74	.	.	.	.	51249
USA	21311	21310	21310	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	21334
UK	5104	5102	1464	800	1027	1105	76	1	171	272	186	.	2	2	.	.	.	.	.	5149
Japan	3364	3364	2047	122	.	.	1195	.	.	.	.	.	.	.	.	.	.	.	.	3410
Germany FR	3287	3240	129	568	712	815	116	538	126	141	95	.	47	47	.	.	.	.	.	3663
Italy	3738	3736	155	383	186	253	209	2424	121	4	1	.	2	2	.	.	.	.	.	3928
France	1978	1978	443	258	578	470	14	5	30	53	127	.	.	.	.	.	.	.	.	2056
Netherlands	1625	1624	23	163	598	574	11	22	63	144	26	.	1	1	.	.	.	.	.	1696
German DR	1303	1303	.	1300	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	1271
Denmark	859	859	3	56	311	478	6	.	.	.	5	.	.	.	.	.	.	.	.	871
Belgium lux	755	747	144	100	324	52	35	2	12	60	18	.	8	8	.	.	.	.	.	792
Hungary	715	715	.	664	13	8	.	30	.	.	.	.	.	.	.	.	.	.	.	735
Spain	449	449	12	83	84	232	37	.	.	1	.	.	.	.	.	.	.	.	.	508
Australia	664	664	371	.	4	.	289	.	.	.	.	.	.	.	.	.	.	.	.	763
Canada	1172	1172	.	.	.	.	1172	.	.	.	.	.	.	.	.	.	.	.	.	1208
Others	6373	6298	104	1161	682	708	59	307	526	34	24	2693	75	1	74	.	.	.	.	3865
DEVELOPING	8092	6374	1088	1267	858	928	1258	457	41	71	82	324	1718	785	933	.	.	.	.	6644
Saudi Arab	756	727	234	67	43	239	105	36	.	3	.	.	29	29	.	.	.	.	.	908
Egypt	1061	982	144	200	268	285	83	2	.	.	.	.	79	79	.	.	.	.	.	1455
Lat America	1369	996	167	.	1	2	826	.	.	.	.	.	373	373	.	.	.	.	.	2056
Others	4906	3669	543	1000	546	402	244	419	41	68	82	324	1237	304	933	.	.	.	.	2225

1/ Volume identified with specific exporters
Volume provenant d'exportateurs identifiés
Volumen indicado por los exportadores

2/ Volume reported by importers
Volume indiqué par les importateurs
Volumen indicado por los importadores

Appendix Table 4. Direction of trade: sawnwood (Non-confierous), SITC 248.3 (1000m^3)

MAJOR EXPORTERS / MAJOR IMPORTERS	WORLD EXPORTS[1]	DEVELOPED	USA	Yugoslavia	France	Romania	Germany FR	Canada	Netherlands	Others	DEVELOPING	Malaysia	Indonesia	Singapore	Philippines	Brazil	Paraguay	Ivory Coast	Others	WORLD IMPORTS[2]
1980																				
WORLD	12616	4290	885	860	475	431	368	305	135	831	8326	3141	1203	1134	742	622	285	277	922	12702
DEVELOPED	8233	3868	805	685	475	351	365	305	134	748	4365	1272	579	533	688	557	6	245	485	8765
Italy	1201	742	45	572	48	34	26	15	2	.	459	53	301	41	17	26	3	18	.	1366
Germany FR	728	278	96	8	83	1	.	21	69	.	450	298	10	49	39	43	.	11	.	987
France	506	79	45	3	.	.	8	11	12	.	427	88	14	132	89	9	.	95	.	757
Canada	442	386	386	.	.	.	.	.	.	.	56	1	.	.	4	51	.	.	.	747
USA	564	167	.	.	.	.	.	167	.	.	397	66	21	12	80	206	2	10	.	675
Netherlands	703	181	69	6	24	1	62	19	.	.	522	249	51	150	45	10	.	19	.	651
UK	433	106	11	4	26	13	29	21	2	.	327	116	16	30	82	61	.	22	.	634
Japan	551	39	33	.	.	.	.	6	.	.	512	159	129	21	199	4	.	.	.	555
Spain	374	248	10	12	93	5	123	1	4	.	126	10	13	.	48	37	.	18	.	522
Belgium Lux	472	326	77	7	145	.	21	38	38	.	146	68	5	55	10	8	.	4	.	489
Australia	210	1	1	.	.	.	.	.	.	.	209	112	.	28	67	2	.	.	.	299
USSR	239	239	.	33	.	206	.	.	.	.	.	.	.	.	.	.	.	.	.	232
Austria	104	68	2	12	4	.	46	1	3	.	36	27	9	.	.	.	.	.	.	159
Others	1706	1008	30	28	52	91	50	5	4	748	698	25	10	15	10	104	1	48	485	692
DEVELOPING	4383	422	80	175	.	80	3	.	1	83	3961	1869	624	601	54	65	279	32	437	3937
Singapore	1262	1	1	.	.	.	.	.	.	.	1261	984	267	.	10	.	.	.	.	1098
Brazil	69	.	.	.	.	.	.	.	.	.	69	.	.	.	.	.	69	.	.	462
Thailand	598	.	.	.	.	.	.	.	.	.	598	473	59	66	.	.	.	.	.	342
Malaysia	103	.	.	.	.	.	.	.	.	.	103	.	100	3	.	.	.	.	.	209
Iran	2	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	195
Argentina	162	.	.	.	.	.	.	.	.	.	162	.	.	.	.	.	162	.	.	189
Saudi Arab	290	7	3	4	.	.	.	.	.	.	283	129	.	151	1	2	.	.	.	180
Hong Kong	115	.	.	.	.	.	.	.	.	.	115	37	42	16	20	.	.	.	.	148
China	94	.	.	.	.	.	.	.	.	.	94	1	87	.	6	.	.	.	.	136
Egypt	118	118	.	118	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	128
Others	1570	296	76	53	.	80	3	.	1	83	1274	243	69	365	17	63	48	32	437	850
1981																				
WORLD	10970	3870	931	631	438	442	366	278	140	644	7100	2800	1112	916	547	569	121	266	769	11594
DEVELOPED	6971	3499	829	528	438	342	362	278	139	583	3472	1095	420	366	501	480	2	233	375	7858
Italy	835	550	43	416	39	19	25	7	1	.	285	30	220	7	4	7	1	16	.	1007
Germany FR	469	244	87	5	72	.	.	10	70	.	225	146	7	28	18	18	.	8	.	723
France	353	96	49	1	.	.	6	22	18	.	257	72	.	61	59	3	.	62	.	516
Canada	464	402	401	.	.	.	.	.	1	.	62	7	2	2	4	47	.	.	.	888
USA	488	167	.	.	.	.	.	167	.	.	321	54	6	13	65	177	.	6	.	670
Netherlands	616	131	65	5	.	.	55	6	.	.	485	329	25	94	20	3	.	14	.	663
UK	525	114	23	2	26	.	35	24	4	.	411	124	17	16	112	117	.	25	.	643
Japan	392	42	36	.	.	.	.	6	.	.	350	89	99	22	136	4	.	.	.	414
Spain	313	256	10	6	99	3	133	2	3	.	57	9	6	2	13	12	.	15	.	445
Belgium Lux	419	289	76	6	134	.	21	16	36	.	130	66	6	47	5	2	.	4	.	405
Australia	220	4	3	.	.	.	.	.	1	.	216	124	12	28	50	2	.	.	.	288
USSR	254	.	.	52	.	200	.	.	2	.	.	.	.	.	.	.	.	.	.	253
Austria	90	57	2	12	.	.	43	.	.	.	33	25	8	.	.	.	.	.	.	118
Others	1533	893	34	23	68	120	44	18	3	583	640	20	12	46	15	88	1	83	375	825
DEVELOPING	3999	371	102	103	.	100	4	.	1	61	3628	1705	692	550	46	89	119	33	394	3736
Singapore	1204	2	2	.	.	.	.	.	.	.	1202	972	224	.	6	.	.	.	.	1063
Brazil	13	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.	13	.	.	335
Thailand	316	.	.	.	.	.	.	.	.	.	316	183	85	48	.	.	.	.	.	433
Malaysia	70	.	.	.	.	.	.	.	.	.	70	.	66	4	.	.	.	.	.	209
Iran	4	.	.	.	.	.	.	.	.	.	4	.	.	4	.	.	.	.	.	195
Argentina	72	.	.	.	.	.	.	.	.	.	72	.	.	.	.	.	72	.	.	189
Saudi Arab	187	6	4	1	.	.	1	.	.	.	181	37	8	126	4	6	.	.	.	151
Hong Kong	103	1	1	.	.	.	.	.	.	.	102	33	46	6	17	.	.	.	.	148
China	143	4	4	.	.	.	.	.	.	.	139	.	105	24	10	.	.	.	.	136
Egypt	72	72	8	64	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	62
Others	1815	286	83	38	.	100	3	.	1	61	1529	480	158	338	9	83	34	33	394	815

1/ Volume identified with specific exporters
Volume provenant d'exportateurs identifiés
Volumen indicado por los exportadores

2/ Volume reported by importers
Volume indiqué par les importateurs
Volume indicado por los importadores

Appendix Table 5. Direction of trade: veneer sheets
SITC 634.1 (1000m^3)

MAJOR EXPORTERS → MAJOR IMPORTERS ↓	WORLD EXPORTS [1]	DEVELOPED	USA	Canada	Germany FR	Portugal	Yugoslavia	France	Belgium Lux	Spain	Japan	Others	DEVELOPING	Malaysia	Philippines	Paraguay	Brazil	Africa	Others	WORLD IMPORTS [2]
1980																				
WORLD	1416	876	295	162	76	57	44	39	38	32	26	107	540	127	63	63	40	187	60	1760
DEVELOPED	1100	801	264	162	72	57	44	38	36	29	1	98	299	8	53	-	28	177	33	1409
USA	175	135	-	133	1	-	-	1	-	-	-	-	40	1	18	-	16	5	-	368
Germany FR	215	157	121	12	-	1	1	10	12	-	-	-	58	-	15	-	8	35	-	151
France	94	54	5	1	5	20	-	-	5	18	-	-	40	-	2	-	-	38	-	136
USSR	22	22	-	-	10	-	11	-	1	-	-	-	-	-	-	-	-	-	-	135
Japan	10	2	2	-	-	-	-	-	-	-	-	-	8	3	5	-	-	-	-	111
Italy	93	68	32	2	7	-	22	2	1	2	-	-	25	-	-	-	2	23	-	82
UK	54	46	7	-	5	26	-	2	2	4	-	-	8	3	-	-	-	5	-	77
Netherlands	57	34	4	1	6	10	1	1	10	1	-	-	23	-	3	-	-	20	-	67
Israel	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46
Belgium Lux	31	18	7	1	6	-	1	3	-	-	-	-	13	-	2	-	-	11	-	32
Canada	43	42	42	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	30
Denmark	24	20	8	1	7	-	1	2	1	-	-	-	4	-	-	-	-	4	-	24
German DR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
Australia	9	1	1	-	-	-	-	-	-	-	-	-	8	1	7	-	-	-	-	18
Others	272	201	34	11	25	-	7	17	4	4	1	98	71	-	-	-	2	36	33	113
DEVELOPING	316	75	31	-	4	-	-	1	2	3	25	9	241	119	10	63	12	10	27	351
Brazil	56	-	-	-	-	-	-	-	-	-	-	-	56	-	-	56	-	-	-	87
Singapore	84	-	-	-	-	-	-	-	-	-	-	-	84	80	4	-	-	-	-	67
Saudi Arab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32
Afganistan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27
Oman	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	25
Others	173	75	31	-	4	-	-	1	2	3	25	9	98	36	6	7	12	10	27	113
1981																				
WORLD	1359	879	291	215	66	47	34	37	38	22	33	96	480	134	39	33	43	178	53	1771
DEVELOPED	1032	767	247	208	63	39	34	37	36	18	1	84	265	2	36	-	30	168	29	1342
USA	238	191	-	189	1	-	-	-	1	-	-	-	47	-	21	-	18	8	-	382
Germany FR	180	139	109	11	-	-	-	13	6	-	-	-	41	-	3	-	7	31	-	125
France	30	19	1	-	5	1	-	-	-	12	-	-	11	-	-	-	-	11	-	131
USSR	14	14	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	95
Japan	7	3	1	-	2	-	-	-	-	-	-	-	4	1	3	-	-	-	-	114
Italy	69	45	16	2	6	-	14	8	2	1	-	-	24	-	-	-	1	23	-	64
UK	55	52	6	-	6	35	-	2	-	3	-	-	3	1	-	-	-	2	-	77
Netherlands	31	14	2	-	4	1	-	-	7	-	-	-	17	-	1	-	-	16	-	54
Israel	2	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46
Belgium Lux	22	17	5	-	6	-	-	6	-	-	-	-	5	-	-	-	-	5	-	32
Canada	80	77	77	-	-	-	-	-	-	-	-	-	3	-	1	-	-	3	-	34
Denmark	20	18	3	-	10	-	1	4	-	-	-	-	2	-	-	-	-	2	-	43
German DR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
Australia	8	2	2	-	-	-	-	-	-	-	-	-	6	-	6	-	-	-	-	21
Others	276	174	24	6	22	2	5	8	20	2	1	84	102	-	2	-	4	67	29	105
DEVELOPING	327	112	44	7	3	8	-	-	2	4	32	12	215	132	3	33	13	10	24	429
Brazil	29	-	-	-	-	-	-	-	-	-	-	-	29	-	-	29	-	-	-	84
Singapore	91	1	1	-	-	-	-	-	-	-	-	-	90	90	-	-	-	-	-	97
Saudi Arab	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51
Afganistan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27
Oman	10	-	-	-	-	-	-	-	-	-	-	-	10	10	-	-	-	-	-	49
Others	196	110	42	7	3	8	-	-	2	4	32	12	86	32	3	4	13	10	24	121

[1] Volume identified with specific exporters
Volume provenant d'exportateurs identifiés
Volumen indicado por los exportadores

[2] Volume reported by importers
Volume indiqué par les importateurs
Volumen indicado por los importadores

Appendix Table 6. Direction of trade: plywood

SITC 634 (1000m^3)

MAJOR EXPORTERS / MAJOR IMPORTERS	WORLD EXPORTS[1]	DEVELOPED	Canada	Finland	USSR	USA	France	Romania	Belgium Lux	Japan	Others	DEVELOPING	Korea Rep	China	Singapore	Malaysia	Philippines	Indonesia	Others	WORLD IMPORTS[2]
1980																				
WORLD	6578	2766	548	531	314	248	169	135	113	104	604	3812	946	868	616	474	367	245	296	5908
DEVELOPED	4525	2452	542	481	236	204	151	105	106	92	535	2073	707	543	156	167	277	62	161	4352
USA	1002	157	44	23	7	-	-	-	-	83	-	845	340	305	2	6	166	26	-	1001
UK	634	402	187	92	61	44	4	6	5	3	-	232	26	26	60	58	46	16	-	772
Netherlands	316	206	61	33	5	10	61	-	36	-	-	110	54	24	14	2	16	-	-	488
Germany FR	296	267	68	107	10	14	47	11	10	-	-	29	10	12	5	2	-	-	-	486
France	182	127	39	36	-	-	-	-	52	-	-	55	21	3	11	7	13	-	-	335
Belgium Lux	239	107	38	11	6	39	10	3	-	-	-	132	47	22	26	6	31	-	-	209
Denmark	113	91	41	18	-	31	1	-	-	-	-	22	8	3	9	2	-	-	-	136
Italy	102	82	31	18	-	15	13	5	-	-	-	20	5	12	3	-	-	-	-	125
Japan	105	57	26	-	26	5	-	-	-	-	-	48	34	4	-	-	1	9	-	113
Sweden	91	86	2	66	13	-	-	5	-	-	-	5	1	4	-	-	-	-	-	109
Canada	71	29	-	3	3	23	-	-	-	-	-	42	12	25	1	-	4	-	-	81
Switzerland	17	17	1	10	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	78
Norway	32	29	-	29	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	67
Australia	44	-	-	-	-	-	-	-	-	-	-	44	-	39	4	1	-	-	-	63
Others	1281	795	4	35	105	21	11	75	3	6	535	486	146	64	21	83	-	11	161	289
DEVELOPING	2053	314	6	50	78	44	18	30	7	12	69	1739	239	325	460	307	90	183	135	1556
Saudi Arab	300	26	-	20	-	5	-	-	-	1	-	274	139	94	37	4	-	-	-	327
Singapore	274	1	-	1	-	-	-	-	-	-	-	273	-	17	-	206	-	50	-	248
Hong Kong	326	2	1	-	-	-	-	-	-	1	-	324	-	56	42	38	88	100	-	237
Egypt	91	20	-	9	10	-	1	-	-	-	-	71	26	45	-	-	-	-	-	106
Nigeria	23	-	-	-	-	-	-	-	-	-	-	23	-	16	7	-	-	-	-	65
Others	1039	265	5	20	68	39	17	30	7	10	69	774	74	97	374	59	2	33	135	573
1981																				
WORLD	7013	2755	408	520	324	437	162	110	121	107	566	4258	1068	868	587	469	408	535	323	6423
DEVELOPED	4525	2408	405	442	244	389	148	86	114	95	485	2117	601	590	231	112	311	85	187	4671
USA	1028	147	42	13	7	-	-	-	-	85	-	881	346	320	5	5	205	-	-	1226
UK	784	359	189	84	-	79	4	-	-	3	-	425	75	28	114	87	63	58	-	1008
Netherlands	233	123	24	37	3	38	-	-	21	-	-	110	56	21	16	2	13	2	-	446
Germany FR	267	246	44	102	6	25	46	9	14	-	-	21	8	8	2	2	1	-	-	472
France	122	107	17	32	-	8	-	-	50	-	-	15	1	5	2	2	5	-	-	261
Belgium Lux	277	203	33	21	-	78	71	-	-	-	-	74	29	14	13	5	13	-	-	223
Denmark	93	73	9	15	1	46	1	-	-	1	-	20	6	3	7	4	-	-	-	74
Italy	59	45	23	5	-	2	13	2	-	-	-	14	1	12	1	-	-	-	-	102
Japan	154	21	18	-	-	3	-	-	-	-	-	133	4	106	-	3	2	18	-	38
Sweden	56	51	-	49	-	-	-	2	-	-	-	5	1	4	-	-	-	-	-	90
Canada	85	35	-	1	7	23	-	-	-	4	-	50	19	26	-	-	5	-	-	246
Switzerland	14	14	1	8	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	75
Norway	31	25	-	25	-	-	-	-	-	-	-	6	3	-	3	-	-	-	-	65
Australia	56	-	-	-	-	-	-	-	-	-	-	56	1	41	5	1	1	7	-	76
Others	1266	959	5	50	220	87	8	73	29	2	485	307	51	2	63	1	3	-	187	269
DEVELOPING	2488	347	3	78	80	48	14	24	7	12	81	2141	467	278	356	357	97	450	136	1752
Saudi Arab	473	39	-	28	-	10	-	-	-	1	-	434	179	53	68	8	-	126	-	433
Singapore	412	1	-	1	-	-	-	-	-	-	-	411	-	73	-	211	-	127	-	319
Hong Kong	390	2	-	-	-	1	-	-	-	1	-	388	1	83	60	42	92	110	-	237
Egypt	26	11	-	11	-	-	-	-	-	-	-	15	3	12	-	-	-	-	-	86
Nigeria	92	-	-	-	-	-	-	-	-	-	-	92	71	17	4	-	-	-	-	65
Others	1095	294	3	38	80	37	14	24	7	10	81	801	213	40	224	96	5	87	136	612

1/ Volume identified with specific exporters
Volume provenant d'exportateurs identifiés
Volumen indicado por los exportadores

2/ Volume reported by importers
Volume indiqué par les importateurs
Volumen indicado por los importadores

Appendix Table 7. Direction of trade: particle board, SITC 634.32 ($1000m^3$)

MAJOR EXPORTERS / MAJOR IMPORTERS	WORLD EXPORTS [1]	DEVELOPED	Belgium Lux	Austria	Germany FR	Finland	France	USSR	Sweden	Spain	Switzerland	Romania	USA	Portugal	New Zealand	Netherlands	Others	DEVELOPING	Others	WORLD IMPORTS [2]
1980																				
WORLD	5429	5330	1164	675	660	374	372	332	295	281	247	237	227	83	68	62	253	99	99	5716
DEVELOPED	5131	5072	1157	667	654	341	351	302	294	268	247	237	154	79	18	62	241	59	59	5359
UK	1146	1146	212	54	87	221	36	.	133	254	23	20	3	72	4	27	.	.	.	1280
Germany FR	967	967	326	237	-	8	206	10	34	-	106	27	.	.	.	13	.	.	.	971
USA	1	1	.	.	-	.	1	.	.	.	.	.	.	.	.	.	.	.	.	538
Netherlands	614	614	378	5	169	2	50	5	1	.	1	.	2	1	.	.	.	.	.	529
Italy	481	481	7	201	136	.	38	.	.	9	87	3	.	.	.	.	.	.	.	603
France	401	401	216	16	129	1	-	13	.	1	22	.	1	2	.	.	.	.	.	386
German DR	189	189	.	34	.	28	-	113	14	.	.	.	.	.	.	.	.	.	.	180
Poland	169	169	.	.	.	16	-	102	.	.	.	51	.	.	.	.	.	.	.	169
Denmark	105	105	8	.	28	11	.	.	58	.	.	.	.	.	.	.	.	.	.	135
Belgium Lux	104	104	.	2	66	.	19	.	.	.	.	.	.	.	.	17	.	.	.	111
Switzerland	77	77	.	69	7	.	1	.	.	.	.	.	.	.	.	.	.	.	.	84
Norway	52	52	.	.	.	6	.	.	46	.	.	.	.	.	.	.	.	.	.	79
Japan	70	70	.	.	.	.	.	.	.	.	.	.	57	.	13	.	.	.	.	75
Czechoslova	68	68	1	37	1	1	.	21	.	.	.	7	.	.	.	.	.	.	.	73
Ireland	26	26	7	.	6	10	.	.	3	.	.	.	.	.	.	.	.	.	.	66
Others	661	602	2	10	25	39	.	38	5	4	8	129	91	4	1	5	241	59	59	200
DEVELOPING	298	258	7	8	6	33	21	30	1	13	.	.	73	4	50	.	12	40	40	357
Lat America	76	76	.	.	2	.	2	11	1	.	.	.	60	.	.	.	.	.	.	93
Others	222	182	7	8	4	33	19	19	.	13	.	.	13	4	50	.	12	40	40	264
1981																				
WORLD	5153	5049	1022	582	646	342	367	362	348	325	196	156	248	74	54	51	276	104	104	5546
DEVELOPED	4820	4742	1016	578	635	273	347	330	347	315	194	156	167	60	14	51	259	78	78	5210
UK	1094	1094	200	51	98	180	16	.	156	293	19	.	9	55	.	17	.	.	.	1322
Germany FR	822	822	248	236	.	3	185	10	27	.	88	14	1	.	.	10	.	.	.	866
USA	3	3	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	518
Netherlands	445	445	224	2	151	1	65	.	1	.	.	.	.	1	.	.	.	.	.	486
Italy	362	362	2	147	117	.	33	.	.	8	54	.	1	.	.	.	.	.	.	611
France	445	445	238	19	126	2	3	26	-	4	23	.	2	2	.	.	.	.	.	429
German DR	70	70	.	16	.	28	.	.	26	.	.	.	.	.	.	.	.	.	.	180
Poland	141	141	.	.	.	.	.	116	.	.	.	25	.	.	.	.	.	.	.	142
Denmark	126	126	5	.	34	12	.	.	75	.	.	.	.	.	.	.	.	.	.	166
Belgium Lux	119	119	.	2	57	.	40	.	.	.	.	.	.	.	.	20	.	.	.	104
Switzerland	77	77	.	66	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	86
Norway	59	59	.	.	.	6	.	.	53	.	.	.	.	.	.	.	.	.	.	86
Japan	13	13	.	.	.	.	.	.	.	.	.	.	8	.	5	.	.	.	.	12
Czechoslova	9	9	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	88
Ireland	30	30	.	.	8	11	.	.	5	3	.	.	.	1	.	2	.	.	.	94
Others	1005	927	99	30	33	30	5	178	4	7	10	117	146	1	7	1	259	78	78	260
DEVELOPING	333	307	6	4	11	69	20	32	1	10	2	.	81	14	40	.	17	26	26	336
Lat America	54	54	.	.	2	.	.	.	.	.	.	.	50	2	.	.	.	.	.	87
Others	279	253	6	4	9	69	20	32	1	10	2	.	31	12	40	.	17	26	26	249

1/ Volume identified with specific exporters
Volume provenant d'exportateurs identifiés
Volumen indicado por los exportadores

2/ Volume reported by importers
Volume indiqué par les importateurs
Volumen indicado por los importadores

Appendix Table 8. Direction of trade: fibreboard SITC 641.6
(1000m^3)

MAJOR EXPORTERS / MAJOR IMPORTERS	WORLD EXPORTS [1]	DEVELOPED	USSR	Sweden	Poland	USA	France	Finland	Spain	Canada	Austria	Romania	Bulgaria	Norway	Yugoslavia	Others	DEVELOPING	Brazil	Others	WORLD IMPORTS [2]
										1980										
WORLD	2308	2056	303	280	201	200	138	120	118	93	72	67	63	60	54	287	252	183	69	2014
DEVELOPED	1896	1716	264	227	158	150	120	97	90	91	70	67	53	44	38	239	180	131	49	1763
UK	271	256	12	65	54	6	15	50	26	1	.	1	.	25	1	.	15	15	.	316
Germany FR	216	206	.	38	38	2	39	6	28	.	41	8	2	1	3	.	10	10	.	301
USA	181	111	12	1	7	.	.	1	.	90	.	.	.	.	.	.	70	70	.	238
Poland	88	88	88	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	160
Netherlands	105	83	13	42	4	.	.	12	6	.	4	.	1	1	.	.	22	22	.	132
France	22	22	.	5	4	.	.	3	10	.	.	.	.	.	.	.	.	.	.	125
Italy	115	114	39	.	2	6	3	.	13	.	16	3	.	.	32	.	1	1	.	101
German DR	74	74	53	5	7	.	.	9	.	.	.	.	.	.	.	.	.	.	.	76
Belgium Lux	54	47	.	9	7	.	18	3	3	.	.	2	5	.	.	.	7	7	.	75
Canada	151	148	15	.	5	128	.	.	.	.	.	.	.	.	.	.	3	3	.	71
Denmark	78	78	4	43	15	.	.	2	.	.	.	.	.	14	.	.	.	.	.	60
Switzerland	6	6	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29
Others	535	483	28	19	9	8	53	11	4	.	9	53	45	3	2	239	52	3	49	79
DEVELOPING	412	340	39	53	43	50	10	23	28	2	2	.	10	16	16	48	72	52	20	251
Nigeria	95	79	.	34	31	.	.	11	.	.	.	.	.	2	1	.	16	16	.	55
Argentina	15	7	.	7	.	.	.	.	.	.	.	.	.	.	.	.	8	8	.	25
Singapore	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	.	21
Morocco	18	18	.	.	.	1	.	.	11	.	.	.	5	.	1	.	.	.	.	21
Saudi Arab	5	5	.	.	.	4	.	.	.	.	.	.	.	1	.	.	.	.	.	21
Malaysia	10	9	.	.	.	7	.	.	.	.	.	.	.	2	.	.	1	1	.	21
Others	265	222	39	12	12	38	10	12	17	2	2	.	5	11	14	48	43	23	20	87
										1981										
WORLD	2415	2134	319	241	162	338	136	115	131	83	57	62	47	69	53	321	281	209	72	2043
DEVELOPED	2104	1912	278	232	128	320	134	104	103	82	55	62	39	48	37	290	192	143	49	1792
UK	277	263	.	68	48	37	20	31	26	2	1	.	.	27	3	.	14	14	.	300
Germany FR	176	166	8	24	27	10	48	6	10	.	30	.	.	.	3	.	10	10	.	238
USA	217	143	16	2	17	.	.	3	.	79	.	26	.	.	.	.	74	74	.	273
Poland	278	278	243	7	.	.	.	.	.	.	.	.	28	.	.	.	.	.	.	165
Netherlands	76	55	.	24	2	11	.	13	1	.	4	.	.	.	.	.	21	21	.	123
France	14	10	.	2	.	3	.	.	5	.	.	.	.	.	.	.	4	4	.	137
Italy	33	33	.	.	.	.	8	.	3	.	12	.	.	.	10	.	.	.	.	104
German DR	21	21	.	5	6	.	.	9	.	.	.	.	1	.	.	.	.	.	.	76
Belgium Lux	76	70	.	.	5	8	52	2	1	.	.	.	1	.	1	.	6	6	.	60
Canada	217	207	9	1	.	197	.	.	.	.	.	.	.	.	.	.	10	10	.	95
Denmark	54	54	.	26	10	3	.	.	1	.	.	.	.	14	.	.	.	.	.	57
Switzerland	16	16	.	1	5	2	.	.	.	.	7	.	.	1	.	.	.	.	.	41
Others	649	596	2	72	8	49	6	40	56	1	1	36	9	6	20	290	53	4	49	123
DEVELOPING	311	222	41	9	34	18	2	11	28	1	2	.	8	21	16	31	89	66	23	251
Nigeria	84	46	.	1	24	.	.	1	20	.	.	.	.	.	.	.	38	38	.	55
Argentina	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	.	25
Singapore	5	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	4	4	.	17
Morocco	14	14	.	4	.	.	.	.	8	.	.	.	2	.	.	.	.	.	.	21
Saudi Arab	6	6	.	.	.	1	.	1	.	.	.	.	.	4	.	.	.	.	.	21
Malaysia	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	21
Others	196	155	41	4	10	17	2	8	.	1	2	.	6	17	16	31	41	18	23	91

[1] Volume identified with specific exporters
Volume provenant d'exportateurs identifiès
Volumes indicado por los exportadores

[2] Volume reported by importers
Volume indiqué par les importateurs
Volume indicado por los importadores

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